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THE NINTH MEETING OF THE BOARD OF AGRICULTURE IN INDIA.

THE Ninth Meeting of the Board of Agriculture was held at Pusa from 7th to 12th February 1916, under the presidency of Mr. Bernard Coventry, C.I.E., Agricultural Adviser to the Government of India. Before proceeding to a consideration of the subjects discussed at this meeting it would not perhaps be out of place to mention the difference in the functions of the Board of Agriculture as constituted for India and the similar body in Great Britain. The duties of the Indian Board are purely advisory, while the English Board has administrative functions and is therefore working continuously. The Board of Agriculture in India meets every two years, alternately at Pusa and in one of the provinces. Thus the eighth meeting was held at Coimbatore towards the close of the year 1913.

The advantages of such an institution cannot be overrated. It brings together most of the scientific workers engaged in the provinces and thereby gives them the opportunity of comparing notes, exchanging ideas, and seeing that their work does not overlap. It also places before the public a vast mass of useful information and experience gained regarding the subjects brought forward for discussion. And as some of the subjects are of economic importance the notes and discussions thereon have a value all their own.

The meeting at Pusa was attended by 47 members and 24 visitors. Among the visitors may be specially mentioned the Hon'ble Mr. C. H. A. Hill, C.S.I., C.I.E., I.C.S., Member in Council, in charge of the Department of Revenue and Agriculture of the Government of India, Mr. James Mackenna, I.C.S., Col. Hallowes, Director of Military Dairy Farms, The Hon'ble Mr. Morshead, Commissioner, Tirhut Division, Mr. H. M. Lefroy, Imperial Silk

Specialist, Messrs. Collins and Crosthwaite, Registrars of Co-operative Societies, Central Provinces and Bihar and Orissa. Mr. Wynne Sayer, Assistant to the Agricultural Adviser to the Government of India acted as Secretary. Great interest was evinced in the deliberations concerning the closer connection between the Agricultural and Co-operative Departments, Cattle-breeding and Dairying and Soil Denudation by rainfall and drainage, and important practical conclusions were reached on the subjects.

The Hon'ble Mr. C. H. A. Hill opened the proceedings with a short speech in which he eulogized the services of Mr. Coventry and referring to the subjects for discussion he said that one of the most interesting from the point of view of the wider development of improved agricultural methods, is subject VIII relating to the connection between co-operative movement and agriculture. He hoped that the remarks, of the Committee on Co-operation in India, in paragraphs 198-200 of their report would be of considerable help in the deliberations of the Board and said that a basis upon which the work of the agricultural and co-operative movements can be co-ordinated is required to be arrived at. Different methods may be required for different provinces and their working out may take time. But that need not delay the bringing about of unified action between the agricultural employés and the Co-operative Committees throughout India. He urged upon the Board to bear in mind throughout their discussions that it matters far less what means' are employed to bring about co-operation than to secure that such co-operation is brought about. He then proceeded to refer to the question of cattle-breeding and dairying in India. He dwelt upon the advisability of taking long views in all questions connected with the development of Indian agriculture and emphasized that 'it is only through the creation of a body of Indian agriculturists throughout the country, who shall not only be qualified to till the soil efficiently and economically, but who shall have developed a spirit of inquiry and an intelligent desire to keep abreast of the times, that we shall really achieve the results which we aspire to.' The President then addressed the meeting and after gratefully acknowledging the kind references

PLATE II.

BOARD OF AGRICULTURE, 1916

o his work by the Hon'ble Mr. Hill referred to the sad death of Lt.-Col. J. D. E. Holmes and paid a tribute to his work as Imperial Bacteriologist. He then briefly related the principal changes that had taken place in the Agricultural and Veterinary Departments during the last two years and the action taken on the resolutions passed at the last meeting of the Board. He then took a short review of the principal subjects down for discussion.

There were 13 subjects for discussion. Subject I was the confirmation of the Proceedings of the last meeting. This being done committees were appointed to deal with the remaining subjects.

SUBJECTS II AND III. *Programmes of work of (a) the Imperial Department of Agriculture, (b) the Imperial Bacteriologist, Muktesar, (c) the Provincial Agricultural and Veterinary Departments, (d) Native States' Departments of Agriculture.*—Space does not permit us to enter into details of elaborate programmes submitted for the approval of the Board. These programmes were confirmed with slight additions and alterations. With regard to the submission of the programmes for the approval of the Board considerable discussion took place. It was pointed out that the programmes even when approved by the Board could be departed from, that they did not show in some cases, *e.g.*, in that of Mycology what work was to be done and that the reports of the Committees appointed to consider the programmes were generally of very little use. For any information regarding the stage at which a particular investigation has arrived or as to who is working on a particular subject the Annual Reports of the Pusa Research Institute and the Provincial Agricultural and Veterinary Departments which are usually published a few months before the meeting of the Board of Agriculture, might be consulted. It was therefore suggested that the present practice of submitting the programmes to a Committee should be dropped. Several other suggestions were put forward, and it was ultimately resolved that " it be recommended to the Government of India that the submission of programmes both Imperial and Provincial to the Board may be definitely dropped." The Committee appointed to consider the programmes of Provincial and Native States' Departments of Agriculture referred to the difficulty of examining programmes without sufficient notice and suggested that the names of members whom it is proposed to invite to serve on committees should be circulated some time in advance of the meeting. Mr. Wood therefore suggested that a list of subjects for the Board's discussion should be circulated to all Directors of Agriculture and moved a resolution that " the Board recommends that the Directors of Agriculture should be asked to state on which Committees they prefer their men to serve and that the Agricultural Adviser to the Government of India should therefrom appoint Provisional Committees, as long as possible before the Board meets and communicate them to the Provinces." This resolution was accepted by the Board.

With regard to the programme of work of the Imperial Bacteriologist, it was suggested that if possible, an inquiry should be made into the vitality of the rinderpest virus outside the body under varying conditions. The point is of importance to cattle insurance societies and to cattle-owners generally to determine the period within which it would be safe to replace cattle after an outbreak of disease. This recommendation was accepted by Mr. Shilston and the programme was approved.

Some of the programmes of Provincial Veterinary Departments appeared to the Committee to be unduly ambitious having regard to the strength of the superior staff, and it seemed to them that more was being undertaken than could be effectively carried out without an increase of the supervising staff. This applied particularly to the Provinces with a single Superintendent. The extent to which practical effect can be given to much of the work of the Muktesar Laboratory depends on the number of trained men available in the Provinces for carrying out inoculations but practically all Provincial Departments are below their proper strength. For the furtherance of research work the Committee thought co-operative action between the Muktesar staff and Provincial Superintendents very desirable and this can only be ensured by the strengthening of both the Imperial and Provincial staffs. The report of the Committee was accepted by the Board.

SUBJECT IV. *The Policy to be adopted in regard to the supply of cattle to foreign countries.*—Very little information of value can be gathered from the figures relating to the export of animals from the various Indian ports, since these figures do not distinguish between cattle, sheep and goats but are given for all animals excluding horses, they do not distinguish between animals of good breeds and animals which are of little value except for purposes of slaughter, nor do they indicate clearly the part of India from which the cattle are drawn. It is understood that considerable numbers of inferior cattle are exported from the Madras ports to Ceylon for purposes of slaughter and this is in every way advantageous to stock-owners. A fair number of miscellaneous draught and milch cattle are also sent to Ceylon, the Straits, and Burma for draught and milk purposes, but there is no reason to object to this. The difficulty of regulating the export of valuable breeds would be considerable. As regards the necessity for regulating the export with a view to prevent a serious depletion of the best breeds, the only breeds for which there is any evidence that they are exported on a large scale are the Kankreji breed from North Gujerat and the adjoining Native States (Bombay), the Karachi breed and the Ongole breed of Madras. Of these the latter two have suffered more or less and while this is attributed mostly to export of cattle to foreign countries another factor in the depletion consists of the fact that Karachi cows have been purchased largely by the military and other dairies which take them to distant parts of India where many of their offspring get merged in the local breeds and that numbers of good Ongole cows are taken to Madras by dairymen and are there slaughtered after their period of lactation is at an end. The export of cattle is to the profit of the breeders in the long run. The Board was therefore not in favour of putting any restrictions on the export of cattle that are in demand abroad but recommended the maintenance, in the middle of breeding tracts, of pure herds of such cattle and the assisting of the breeders in every suitable way to extend and improve their present operations.

SUBJECT V. *The Nomenclature of certain posts in the Imperial and Provincial Departments of Agriculture.*—There does not exist at present any uniformity in the designation of officers of the Imperial and Provincial Agricultural Services in different provinces discharging the same duties and having the same emoluments, *e.g.*, the designation of Assistant Director is given to a member of the Provincial Service in one province while in another it is reserved for the junior members of the Indian Agricultural Service. In the Provincial Service various designations are used to denote more or less the same duties, such as Assistant Director, Divisional Inspector, Extra Assistant Director, Agricultural Supervisor, Travelling Inspector and the like. The points for consideration were: (1) whether the designations are uniform in different provinces and whether they correctly indicate the work on which the officers are employed; (2) whether they indicate any relations between the Imperial and Provincial Services; and (3) if no leave reserve is provided in the Imperial Service, whether the Board can recommend a nomenclature which would express the intention of Government to give opportunities to members of the Provincial Service to act in leave vacancies and thereby prove their fitness for permanent promotions. The principal recommendations of the Committee which were adopted by the Board were: (*a*) That Deputy Directors be designated by circles rather than by serial numbers indicative of seniority in the service. The designation of Assistant Director should be reserved for junior officers of the Indian Agricultural Service until they are confirmed in charge of circles. (*b*) There should be no distinction in the Imperial and Provincial Services of officers performing the same duties. (*c*) In order to make the status of experts more clear the words " to Government " and " the name of the Presidency or Province " be added to the designation. (*d*) The executive officers of the Provincial Service be designated Divisional Superintendents of Agriculture in all provinces. With reference to (3) the Committee had no recommendations to make to that end. They believed that their other recommendations would dissipate all confusion.

SUBJECT VI. *Soil denudation by rainfall and drainage: Conservation of soil moisture.*—This subject is of special importance. A large amount of surface soil is washed away every year by rain from the monsoon-fed tracts which impair the fertility of the soil. The damage done to the soil by surface washing in the past is so enormous that it cannot be removed by any system of manuring. It is therefore imperative to take measures to prevent further damage. This subject was brought up for consideration at the meeting held at Coimbatore, but the information then on hand was too meagre for the Board to make any recommendations.

Dr. G. D. Hope, Scientific Officer to the Indian Tea Association, submitted a note describing the elaborate system of terracing and drainage adopted on Java Tea Estates for controlling the rain wash. This note is printed separately as an article in this issue. The Committee agreed with Dr. Hope as to the general adaptability of these methods to conditions in Assam and elsewhere.

The losses due to soil erosion are to a great extent preventable and in the case of planting areas the Board recommended that the Government of India be asked to bring to the notice of the planters, through the medium of the Indian Tea Association, United Planters' Association of Southern India, District Officers, and other channels that effective measures should be taken to prevent soil erosion on the existing areas and when new areas are opened. They also suggested that Local Governments should safeguard against this danger of erosion when fixing the conditions on which new lands are given out.

In Peninsular India the question of preventing soil erosion has already been taken in hand in Bombay. Preliminary enquiries are complete, and the Director of Agriculture has formulated definite proposals to begin the work on an organized line. To carry out this work the Board recommended that the Government of India should be requested to place at the disposal of the Bombay Department for a period of five years an engineer with experience and aptitude for agricultural work. The sole duties of this officer should consist in the preparation and execution of schemes of embankment and drainage adapted to local conditions.

As regards the alluvial tracts of Northern India, the "Pusa" system of surface drainage is found to materially increase the cropping power of the land. For an efficient application of this method it is essential that the natural drainage systems of these tracts should be closely studied. In North Bihar the natural drainage has been so interfered with that the high flood level is rising at the rate of several inches a year and thereby doing an increasing amount of injury to crops. The Commissioner of Tirhoot has taken in hand the question of improvement of the drainage in North Bihar with a view to preventing as far as possible the recurrence of floods. The Board welcomed this attempt.

In connection with the subject of conservation of moisture the Committee felt that while the advantages of interculture and of surface cultivation generally are well known in many parts of India and attention is being paid to it by the Agricultural Department a great deal remains to be done both to improve the best indigenous practices and also to introduce these methods into new localities. The results obtained at Quetta indicated that for every hundred acres of irrigated land the water lost every year would produce wheat and *bhusa* worth Rs. 50,000. The Board expressed their opinion that any experiments having for their object the discovery of the most economical and efficient use of irrigation water should be encouraged and developed by the Agricultural Department.

SUBJECT VII. *How the energies of the Veterinary Department can best be utilized in the control and check of cattle diseases and what means should be adopted for increasing the numbers of the subordinate staff as recommended at the last meeting of the Board.*—This subject was also discussed at the last meeting. For the control and check of cattle diseases it is essential for the staff of the Veterinary Department, both superior and subordinate, to gain the confidence of the villagers and be in closest possible touch with them and the local district officers. But in most of the provinces the Departments are understaffed in all grades. Schemes for the expansion of the subordinate staff have, however, either been sanctioned or are in contemplation in most provinces. But the difficulty in obtaining trained men is causing delay in carrying through the schemes where sanctioned. This is especially the case in the United Provinces and Bihar and this difficulty is not likely to be satisfactorily removed until funds permit the construction of the proposed Veterinary College in the United Provinces to serve the needs of that province and of the Hindi-speaking portion of Bihar. In connection with the inoculation work and the class of men by whom it is to be done the opinion of the Committee was that generally it is most undesirable to employ any but well-trained men in any of the ranks of service whenever such men are to be placed in positions of semi-independence. The Committee recommended that the subordinate staff should be under the control of the Veterinary Department. It also suggested the increase of the superior staff before a large subordinate staff is recruited in order to ensure adequate supervision, drive and general control. The report of the Committee was accepted by the Board.

SUBJECT VIII. *The Co-operative movement in its relation to agriculture. How to organize the relations between the Co-operative Societies, whether dealing with credit or some other branch of agricultural organization, and the Agricultural Departments? Whether there is any need to encourage Agricultural Associations in view of the special facilities possessed by Co-operative Societies for carrying on propaganda.*—This was one of the important subjects before the Board. It was considered by a strong Committee including two Registrars of Co-operative Societies which made ten recommendations and these with slight modifications in some cases were passed as resolutions.

(1) Agricultural Associations perform useful functions where a central co-operative association either does not exist or is not fully developed and even where such associations do exist there is no need to discourage Agricultural Associations when the members really undertake pioneer work. But when central co-operative associations are fully developed the Agricultural Department should use them first and foremost as a means for demonstration and introduction of improvements and should concentrate its attention on them. This view of the Committee was accepted by the Board.

(2) The next question was with regard to the finance of Central Banks: whether it is desirable that separate capital should be set aside for agricultural improvements which should be distinctive from the banking capital. It was pointed out that a Central Bank would involve itself in difficulties if it were to start trading on a large scale. The Board agreed with the view of the Committee that the working capital of the bank should not be employed in commercial enterprises. For the distribution of seeds, implements, and other similar activities the bank should either act as an agent or raise separate capital or make allotments out of profits or reserves. The agency system has been found to work satisfactorily in the Central Provinces. But a form of Central Association with separate share capital in which societies or individuals would become shareholders might well be developed. All dealings of this kind should be for cash only and members must, if necessary, borrow from their credit societies for these purposes.

(3) It was resolved that where credit societies exist in any village they must be utilized for getting orders for seed, etc., but as societies they should not engage in trade but only give loans to their members to make purchases. Agreements to purchase should be taken from individuals before orders are given. Where no credit societies exist co-operative associations, such as those working in the Northern Circle of the Central Provinces, might be found useful. The Board resolved that unregistered co-operative associations for the supply of pure seed, etc., should be discouraged.

(4 and 5) In connection with the steps to be taken to bring the officers of the Agricultural and Co-operative Departments into closer touch, etc., the Board resolved that this could be done by making the staff of the Agricultural Department familiar with the principles of co-operation and by giving to the staff of the Central Bank such practical training in agriculture as may be necessary and possible. The other step considered necessary for this purpose was that, in addition to Agricultural Inspectors and Assistants who are to be appointed in each district, a Government official who should be subordinate to the Deputy Director and

the Agricultural Inspectors or Assistants, should be attached to each Central Bank which is sufficiently developed. Such a man should be a practical cultivator who can read and write.

(6 and 7) The Board resolved that Government should bear the cost of all demonstration work in each area, and for this purpose they should find the money. It was also resolved that in places in which the Agricultural Department propose to open demonstration farms in tracts in which there are also well developed Central Banks one at least should be started at the head-quarters of such banks at the expense of Government.

(8) As regards cattle insurance the opinion of the Board was that it is unsafe unless adequate arrangements are made for dealing with outbreaks of epidemic diseases and that the fixation of tariffs depends on local conditions based on more satisfactory actuarial data than those available at present.

(9 and 10) The proposals for the Development Commissioner made by the Committee on Co-operation in India did not commend themselves to the Board. While the Board desires to emphasize the necessity of adequate programmes of general development and of the regular allotment of funds it considers that in respect of the Co-operative movement and of the Agricultural Departments these proposals are unsuitable. It appears from the report that the officer appointed to this post would be mainly selected on account of his qualifications as a co-operative organizer, which means the appointment of a non-technical officer at the head of the Agricultural Department. Again, where the Director of Agriculture and the Registrar are directly under Government it would involve extra delay and loss of efficiency if another officer is appointed between them and Government. The real improvement in the opinion of the Board lies in placing these officers under the direct control of Government in the provinces where they are at present under a Financial Commissioner or Board of Revenue. The necessity of a closer connection between the Co-operative and Agricultural Departments was, however, recognized, and the Board recommended that co-ordination should be secured by the formation of a Board consisting of the Registrar, the Director of Agriculture and the

Director of Industries where he exists, which would meet from time to time and make their joint representations to Government when necessary. It was further resolved that it would be a good thing if some at least of the Directors of Agriculture could attend the Imperial Conference of Registrars.

SUBJECT IX. *To what extent forest tracts act as harbours of rinderpest during the rainy season and what steps can be taken to combat the condition.*—In some provinces serious outbreaks of rinderpest do synchronize with the return of the cattle from the forests and hills to the plains, but the Committee was unable to make any recommendations on the subject on account of lack of any direct evidence as to the relative importance of this question, the impossibility for economic reasons of closing such common grazing in forests, the difficulties in carrying out effective inoculations in such remote tracts, and the shortage of the staff in the Veterinary Department.

SUBJECT X. *Indian Sugar Industry.*—This subject was fully discussed at the last two meetings. The Committee drew out a detailed report showing the progress made in different provinces. In connection with the small plant installed at Nawabgunj under Mr. Hulme's supervision the Board regretted that sufficient steps were apparently not taken to ensure a proper supply of cane to the factory during the last two years to give the experiment a fair chance of success. The Board could only recommend the continuance of the experiment if the United Provinces Government could undertake to obtain for the factory a sufficient amount of cane locally to keep it working at optimum conditions whether by giving advances to the cultivators to grow cane or otherwise. A balance sheet showing the results of the experiment was considered to be essential in framing a judgment as to its value.

It was noted with regret that the sugarcane station recommended by the Board in 1911 for North Bihar had not yet materialized. In view of the fact that this tract has so far proved itself one of the most promising fields in India for the production of white sugar on a manufacturing scale and for the establishment of the central factory system on a sound commercial basis, a sugarcane station is of prime importance for the proper maintenance of the industry and should be started as soon as possible. And in view of the difficulties that appear to have prevented the establishment of such a cane station hitherto, the Board recommended that the interests of the sugarcane cultivation in North Bihar should be definitely committed to the charge of an officer of the Agricultural Service.

Other resolutions passed by the Board were regarding (1) the continuation of the Kamrup Experimental Sugarcane Farm in Assam, till it has been sufficiently shown whether sugarcane can or cannot be grown in that tract on large scale at a profit, and (2) the continuation of the cane-breeding station at Coimbatore in Madras, which has already done much valuable work in connection with the raising of seedlings, under general financial and administrative arrangements similar to those which have hitherto prevailed.

SUBJECT XI. *Cattle Breeding and Dairying in India.*—This subject was also considered at the last meeting of the Board. A memorandum on the scheme for cattle-breeding and dairying in India prepared by the Agricultural Adviser formed the basis of discussion on the subject. The Committee considered the scheme in detail and submitted the report on the basis of which the Board resolved that in order to make satisfactory progress in the develcpment of good breeds of milch cattle in India and in dairying an officer should be appointed on the Imperial staff under the title of Imperial Dairy Expert, his duties being (1) the control of the cattle-breeding farms and dairy operations contemplated in the scheme; (2) the supervision of dairy instruction; (3) the study and improvement of existing dairy methods in the country and the establishment of the industry on a commerical basis. He would generally advise and assist Local Governments, Provincial Officers, and Military Dairy Farms. The Board also considered that the arrangements proposed and the estimate prepared by the Committee were reasonable and the officer when once appointed should not be liable to transfer. It was resolved that in the opinion of the Board the offer by the military authorities of the herds of various breeds of pure bred Indian cows and buffaloes as well as the facilities for conducting further breeding operations on the military dairy farms is of extreme value and should be gladly accepted. Advantage should be taken of this offer as soon as the Imperial Dairy Expert is appointed. The appointment of a Chemist was recommended at least for a period of 10 years to investigate the problems regarding the food values and the digestive capacity of Indian farm animals. Other principal resolutions were with regard to the establishment of the dairy schools to fill the need for trained dairy managers, arrangement for immunization of cattle against disease by increasing the Muktesar staff, the advisability of instituting an investigation into the existing supply and demand for dairy produce on the lines of the inquiry made by the Bombay Department before any fixed policy is adopted in any province for the encouragement of the dairy industry, and lastly, the legislation against adulteration in dairy produce. The Board reaffirmed the resolution passed at Coimbatore in 1913 with regard to the conditions for the improvement of cattle in India (p. 16 of the Proceedings) and desired to lay special stress on points 3 and 9 in the report of the Committee then adopted.

SUBJECT XII. *The best agency for controlling cattle-breeding.* The question for consideration was which of the two Departments, Agricultural or Veterinary, is the better agency for controlling cattle-breeding. Cattle-breeding is a distinct business apart from both agricultural and veterinary work, and requires special qualifications. The officer appointed to deal with this business should devote his whole attention to it. It is also very desirable that he should remain on the job all his service so as to attain optimum results. The Committee considered that in the existing cattle-breeding organization in India it would be unfortunate if either of these two Departments were entirely disconnected with cattle-breeding or wtih the wider questions comprised in the term "animal husbandry." In connection with animal husbandry the problems appear to differ in different provinces and the organization has developed on different lines. It was therefore considered that it would be best for the various provinces to arrange for the control of animal husbandry with reference to the particular problems involved and the nature of the agricultural and veterinary organization that may be in existence or contemplated. This was accepted by the Board.

SUBJECT XIII. *Fisheries.*—The question for consideration was whether the subject of fisheries should be dealt with by the Board of Agriculture and whether the Fishery Experts of Bengal, Bihar and Orissa, Madras, and the Punjab should be made permanent members of the Board. Excepting Bengal and Bihar and Orissa, the Fishery Department in other Provinces is separate from Agriculture and even in Bengal, Bihar and Orissa it is connected with the Agricultural Department by accident. The Board therefore decided the question in the negative.

This brought the consideration of subjects on the agenda paper to a close when Mr. Keatinge invited the Board to hold their next meeting at Poona. This offer was accepted subject to the approval of the Government of India. Before dispersing thanks were voted to the President who was shortly retiring from the post of Agricultural Adviser to the Government ot India, to Mr. Dobbs for successful work as Secretary during the two previous meetings of the Board and to Rao Saheb Nagarji, Superintendent, Office of the Agricultural Adviser to the Government of India, for his valuable services in connection with the meetings of the Board.

CATTLE INSURANCE SOCIETIES*

BY

A. C. CHATTERJEE, B.A., I.C.S.,

Registrar, Co-operative Societies, United Provinces.

THE predominating object for loans in our agricultural primary societies is the purchase of plough or draught cattle. A perusal of the status or *haisiyat* registers shows that plough cattle comprise the chief movable property of members. As is well known, houses and buildings in rural localities would fetch very little if sold and the tenant right of occupancy or non-occupancy tenants or of statutory tenants in Oudh cannot be alienated. It is very important therefore from the point of view of the societies as well as of the members to devise means, whereby the loss suffered by members from the death of plough cattle can be minimized. At present if a bullock belonging to a member dies, not only is the tangible and collateral security diminished that the society has for any loans already borrowed by him, but a fresh advance has to be given to him in order that he may replace the deceased animal.

The difficulty has been met in European countries by co-operative societies for the insurance of such cattle. At the conference held in January 1912, Mr. Fremantle outlined a scheme for similar societies in this province. Unfortunately central societies did not take up the idea with any eagerness and there was also some doubt in the minds of competent authorities whether, in the absence of adequate data regarding cattle mortality and also in the absence of sufficient arrangements in rural parts for the prevention and scientific treatment of cattle disease, cattle insurance societies were likely to be successful in this country. Such societies have however now been in operation in Burma for the last five or six years and they have so far proved eminently successful. In view of the great importance of the subject both from the agricultural and co-operative standpoints, the United Provinces Government is anxious that a few experimental societies should be started under favourable conditions and the scheme given a fair trial. Accordingly, after careful deliberation, a small number of societies has been registered in the Mainpuri District, and it is hoped that in other suitable localities co-operators will endeavour to establish a few societies in order to gain experience; if they are successful as there is every reason to hope that with sufficient safeguards they will be successful, such societies can be organized all over the province.

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* A paper read at the Provincial Co-operative Conference held at Lucknow in February 1916

Model by-laws and other particulars may be obtained on application to the Registrar and his staff will give all necessary aid. Societies should be organized only in localities where credit societies have been successfully working and the people are familiar with co-operative ideas. Also only such localities should be chosen in which the cultivators use good plough cattle and appreciate their value. Tracts where the agriculturists trade in cattle, frequently buying and selling them, should be avoided. The members should belong to one village or to two or three contiguous hamlets. They should insure as many as possible of their eligible cattle. At present insurance is confined to healthy bullocks and male buffaloes between the ages of 4 and 12 years. Premium has to be paid every six months (or the insurance lapses) on the value of the animal which is assessed by a valuation committee appointed by the society. The rate of premium has for the present been fixed at one pice per rupee for the six months. This may have to be altered with experience. If the animal dies during the course of the six months, the owner will get back two-thirds of its value after deducting whatever he may be able to realize by selling the hide, etc. Provision is made to secure preventive measures in case of epidemics and also for treatment for sickness. No compensation is given if the animal dies through the neglect of the owner. For the present the cattle insurance society will bank with the district or central bank of the locality, and if, at the end of the experimental stage of the few selected societies, there is any loss, it will be made good by the Government. If the scheme proves successful and the number of societies increases, a re-insurance society will be organized. This cannot however be done for a year or two or until cattle insurance societies are in operation in different parts of the Province, so that the risk can be spread out and thus minimized.

As the writer has recently had an opportunity of studying on the spot the work of the Burma cattle insurance societies, a brief account of their special features may be interesting. Burma has a great advantage over us in this respect for cow's milk is seldom used for human consumption. Consequently the calves get all the milk and the cattle are more healthy and stronger than in this province. There is also plenty of grazing except in certain seasons of the year. The village and tenure systems of Burma moreover enable the villagers to prevent individuals from adopting practices pernicious to the general welfare of all the cattle in the village. The cattle insurance societies have given further stimulus to this system and sanitary measures for the protection of the cattle are adopted in every village as soon as any disease or epidemic is threatened. It is hoped that in this province also cattle insurance societies will help in this direction.

In Burma the area of a cattle insurance society is ordinarily limited to one village. Membership is practically confined to the members of a credit society. (The Registrar of Burma does not consider this rule to be essential, but it has been adopted in order to minimize the chances of dishonesty on the part of the cattle insurance society in its dealings with the re-insurance society. Any such dishonesty can now be punished by the closing of the credit society, which is bound to prove a severe misfortune to all its members.) Members are encouraged to insure all their eligible cattle, but at present they are not compelled to do so. Plough bullocks and buffaloes between the ages of 4 and 12 are insurable. The valuation is made every six months when the premium has to be paid. The present rate of premium is five per cent. per annum. On the death of an insured animal, an indemnity of two-thirds of the value assessed, less the price of the hide and carcase, is paid out.

The valuation work seemed to me to be easier in Burma than it is likely to be here. The cattle are more or less of the same value if of the same age. In other words the standard of care bestowed on the animal from the time of its birth is uniformly high and there are not many different breeds to be taken into account It may also be noted that the meat of a dead animal is eaten by all classes of Burmans. The price of the carcase is thus a substantial sum and the indemnity payable is appreciably reduced thereby.

A re-insurance society has been organized for the whole of Burma of which the Registrar is at present the honorary and *ex-officio* manager. Half the premia collected by the insurance society is deposited in the local credit society. The other half is sent to the re-insurance society along with a list and particulars of cattle insured and their valuation every half year. If any animal dies, half the indemnity that has to be paid comes from the re-insurance society, the remaining half has to be made good from the funds of the primary insurance society. The latter has two separate funds, *viz.:* (1) the general fund consisting of all premia realized during the year, and (2) the reserve fund consisting of fines, entrance fees, donations, profits of previous years, etc. In the event of the funds received as premia during the year proving insufficient to meet the claim of half the indemnity payable by the primary society, half of the reserve fund may be drawn upon in any one year with the Registrar's sanction to meet the deficiency. If the funds are still insufficient the indemnities for all animals that have died during the year will be proportionately reduced. I am informed by the Registrar that so far no society has suffered a deficit. The re-insurance society was organized only about a year ago. It banks with the Upper Burma Central Bank, which is the Provincial Co-operative Bank for Burma.

In Burma only a few tracts have any district or central bank. The link between the Provincial Bank and the primary credit society is the "Guaranteeing Union." A cattle insurance society becomes a member of the local union in order to secure supervision from it, but undertakes no financial responsibility in it.

PROTECTIVE INOCULATION OF STOCK IN INDIA.*

BY

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In relation to the control of infectious diseases of stock, as in other directions, India presents problems that are essentially her own and which demand for their solution special study and treatment. Some of the animal diseases prevalent are peculiar to the country and, in a few, the framing of prophylactic measures is at present hindered by our lack of precise information regarding their causal agency, mode of transmission, or other essential feature of their epizootiology. However, in the case of the more important microbial diseases of cattle, which are responsible for so large a proportion of the total stock mortality in India, the same difficulty does not exist and methods of prevention and eradication are well known and practised with success in other parts of the world; but similar methods are often entirely inapplicable under existing conditions to cattle owned by natives of India. This applies most forcibly to such measures as slaughter of affected and in-contact animals, segregation and the limitation of movement of stock in infected areas, but it is also true, to a considerable extent, of protective inoculation, which is the only remaining means at our disposal of checking the enormous yearly loss of stock from disease.

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* A paper read at the Third Indian Science Congress, Lucknow, 1916.

At the present time the only diseases for which legislation is in force are Glanders, Surra, Epizootic Lymphangitis and Dourine. These all concern equines principally or solely and against none of them is inoculation practised. Thus, even in those diseases for which we possess prophylactic sera or vaccines, no application of these agents can be made without the full consent of the individual owners.

The difficulties to be overcome by the Veterinary Department in securing voluntary acceptance of inoculation and the requirements to be satisfied by the bacteriologist in respect of the materials employed will be readily appreciated when it is remembered that the great majority of stock owners are ignorant of the meaning of the operation and suspicious both of the effect of the injection and the motives of the operator; but, in addition to these opposition factors which will be overcome in time by teaching and demonstration, there is the strong religious prejudice of Hindus against any form of operative interference with their cattle, even to the insertion of an injection needle in many cases, while an inoculation which endangered to the slightest degree the life of the animal, would not be tolerated under any circumstances.

The first essential therefore of a serum or vaccine for use on cattle in India is safety in action. In other countries stock owners are prepared to sustain some loss from inoculation provided the remaining animals are immunized and the losses do not equal those experienced from the natural disease. Under these circumstances it is frequently possible to employ methods that confer strong and lasting immunity but in this country their application is very limited.

Secondly, immunity should be established rapidly. This can only follow directly after the inoculation when anti-serum is employed, as will be explained later, but the almost immediate cessation of deaths amongst the treated animals, in this case, is a very valuable object lesson and largely contributes to the acceptance of inoculation in districts where the procedure is viewed with distrust.

Obviously the immunity should be strong enough to resist all natural means of infection though it must not be forgotten that acquired immunity is seldom absolute even for a time and several causes may lead to its breakdown.

A consideration of great practical importance is simplicity of the operation, as the inoculating staff is usually small, co-operation of the owners difficult to secure, areas large, and checking of animals treated often impossible as the owners object to any form of marking; thus the need for more than one injection, especially if they have to be separated by an interval of several days, is a serious obstacle to the successful application of the treatment.

The question of duration of immunity has to be made dependent, to a large extent, on the previous considerations and will be discussed when the different methods are reviewed.

The bacteriologist having obtained a serum or vaccine that meets, as far as possible, the requirements just enumerated, the task of securing its acceptance and of applying it in the limitation of the spread of the infective disease in question falls upon the staff of the Veterinary Department. Under existing conditions no attempt at the total eradication of any epizootic cattle disease is possible; the freedom of movement of stock by which contagion is spread, the inability to destroy sources of infection and carry out adequate disinfection, the character of parts of the country, the vast areas covered and the relative smallness of the staff engaged, render such a task hopeless. All that can be done is to deal with outbreaks as they occur, by inoculating, without delay, all cattle in the vicinity, thereby preventing the contagion from finding further suitable hosts in which to propagate, and causing it to die a natural death. The extent to which these efforts will succeed largely depends on the amount of co-operation given by the stock owners themselves and the sufficiency of the veterinary staff, both supervising and subordinate, that is available to carry out the work. The first can only be secured by education and demonstration, by which means the confidence of the people will be obtained; while the provision of the second factor rests with the authorities and the various veterinary colleges.

These are in brief the broad lines on which the practical application of protective inoculation of stock in this country is based the details of their working and the measure of their success may be judged from the reports of the Superintendents of the Civil Veterinary Departments in the various provinces and from the rapid increase, during recent years, in the demand for sera and vaccines.

Before proceeding to discuss the different types of immunity and the various sera and vaccines at present employed, it may be of interest if a short account is given of the initiation of prophylactic measures against animal diseases in this country.

The earliest action appears to have been taken in Madras as long ago as 1866. An Act was then passed for controlling the spread of disease in the province but, as the report of a Commission appointed in 1890 shows, it was never fully worked, and in fact could not have been enforced under the existing conditions. The Government of India made a more serious attempt to cope with the subject of stock diseases in 1868; they appointed a Commission of enquiry which toured the country and submitted a report three years later. The difficulties of the question were dealt with and stress was laid upon the necessity for a thorough expert examination of rinderpest and the other cattle diseases with the object of discovering preventive vaccines, but no legislative control was suggested. Later the Governments of different Provinces were roused, by the seriousness of the losses among cattle, to propose legislation, but in every case the matter was allowed to drop owing to the difficulties presented.

It was only natural that the early discoveries of Pasteur in connection with the protective inoculation of animals should have attracted the notice of the Government of India and have led them to invite his assistance; this they did in 1884. Although rinderpest was the disease for which a protective agent was most urgently required, the vaccines offered in response to the Government's enquiries were for anthrax. This was in fact the only animal disease for the prevention of which any vaccine was then known, but there seems to have been some misunderstanding on this point at the time. However, India appears to have offered such an inviting field for commercial enterprise in the realm of animal vaccines that the scientist formed a company, designated the Animal Vaccine Company, Ltd., solely for the purpose of supplying anthrax vaccine to India and tried with great perseverance to induce the Government to commit itself to wholesale vaccination of cattle, on terms that would have ensured handsome profits to the company.

Two Veterinary Officers and two Indian students were sent to Pasteur's laboratory to be trained in the application of the vaccines and a large quantity of the material must have been sent out, since some years later Pasteur claimed and was paid £800 sterling for training the officers and supplying 50,000 doses of vaccine.

Either as the result of the all too evident commercial motives of the Animal Vaccine Company or of reports from Veterinary Officers in India, or both, the Government declined to enter into an agreement for the supply of vaccine and decided to delay putting into operation any large scheme of vaccination until a more thorough investigation of the nature and prevalence of cattle diseases had been undertaken by competent officers. At this time also doubts were expressed as to whether the anthrax reported in India was the same disease as that existing in Europe and the danger arising from the possibility of introducing a new disease by means of the vaccines was pointed out. This uncertainty arose from the confusion that prevailed at the time in the diagnosis of cattle diseases, deaths from a variety of different causes being returned as anthrax. On this account also the impression was created that the disease was responsible for a much larger mortality than was actually the case.

Accordingly a Civil Veterinary Department was formed and in 1890 certain Veterinary Officers were selected to make what was designated a "bacteriological survey." In the same year Dr. Lingard was appointed as Bacteriologist and given a laboratory at Poona in association with the College of Science.

Two years later, both the Civil Veterinary Department and the Bacteriological Survey were placed on a more definite footing. Mr. (now Colonel) H. T. Pease became Superintendent of the Survey and the functions of the office were defined as being (i) to map out the distribution and prevalence of cattle diseases, (ii) to advise

Veterinary Officers regarding diagnosis, and (iii) to co-operate with the Bacteriologist in the conduct of his investigations.

Meanwhile the location of the laboratory at Poona was found to be unsuitable, both for experimental work and vaccine preparation. Accordingly, the Imperial Bacteriological Laboratory was established in its present situation at Muktesar, in the Kumaon Hills, and sufficient buildings were erected to allow of work being commenced there in 1895.

All this time the Animal Vaccine Company continued their efforts to secure the adoption of the Pasteur Anthrax Vaccines. Representatives were sent out and much correspondence took place. It was not until the year 1900 that the Government of India having received Dr. Lingard's report on the subject. finally refused to entertain further any proposals that the Company might make regarding cattle inoculation.

The grounds on which Dr. Lingard based his objections to the employment of the products of Pasteur's Company were that all vaccines required could be prepared and tested by the Government's own experts without the necessity of paying large sums of money to a foreign business concern, and that the available evidence went to show that anthrax was not sufficiently widespread to justify immunization of cattle against it on a large scale. A feature of the Pasteur vaccines that does not appear to have been realized at the time is, that they are not free from risk, and that in India this constitutes a serious objection to their employment.

The protracted negotiations between the Government of India and the Animal Vaccine Company are described at some length in a summary written by Sir Edward Buck in 1896 and their only interest now lies in the fact that they undoubtedly led to the first establishment in this country of a laboratory for research in stock diseases, and the manufacture of protective agents for their control.

Since 1895, this work has been carried out at the Muktesar Laboratory under the direction first of Dr. Lingard and then of the late Lt.-Colonel J. D. E. Holmes; to these two workers the credit must be given of initiating and organizing the methods of serum and vaccine preparation in India on the scale at present in operation.

In order to make clear why certain methods of protective inoculation are free from risk while in others there is an element of danger, and to explain, as far as possible, the reasons for the variations in the character and duration of immunity produced in different ways, reference may here be made to the main points involved in the action of those sera and vaccines which are employed in India at the present time.

By making this restriction the production of immunity against diseases due to protozoon infections, such as Redwater and the other Piroplasmoses, will not be discussed; several forms of this group of diseases are very widely spread throughout India, but all the native breeds of cattle have a high degree of immunity against them and in consequence they have attracted little attention. In relation to the importation of pedigree stock from England and other countries more or less free from these infections, the subject however is of great interest and practical importance and will require investigation in the near future.

It is a well-known fact that when a person or animal recovers from an attack of a bacterial disease, they are protected usually for a long period against a further attack of the same disease and as a result are said to have acquired immunity.

All the Indian stock diseases in which inoculation is practised are caused by micro-organisms which produce their injurious effect in one of two ways, either (i) by spreading through the body in the blood or lymph stream as in anthrax, rinderpest, etc., or (ii) by remaining at the point of infection and forming toxins which are absorbed and poison the cells of the body, as is the case in tetanus. Immunity in both classes is due to the formation in the body of certain substances which, according as they aid in the destruction of the invading organisms or neutralize liberated toxin, are known as bacteriolysins and anti-toxins respectively.

The animal body, either as the result of an attack of a particular disease or the injection of various animal cells and fluids or poisons of different kinds, is capable of forming many other varieties of anti-body each having some specific action on the agent that provoked its formation, but any account of these is outside the scope of the present paper.

The bacteriolysins and anti-toxins, like the other anti-bodies, circulate in the blood plasma and body fluids and after recovery from the disease the tissues responsible continue to produce them for some time, thus maintaining the protection. For this reason such a recovered animal is said to possess an active immunity against that particular disease. When an actively immunized animal receives large and repeated injections of the organism in question or its toxin, as the case may be, its tissues are stimulated to form anti-bodies in greatly increased amount and the animal is then said to be hyper-immune. The anti-bacterial and anti-toxic sera used in practice for inoculation are obtained from the blood of such hyper-immunized animals.

If a susceptible animal receives an inoculation of anti-serum it will at once acquire an immunity. the strength and duration of which will entirely depend on the quantity of anti-body contained in the injected serum ; the tissues of the injected animal itself will form no anti-bodies so that its state of insusceptibility is known as passive immunity.

Since the serum and its contained anti-bodies are eliminated or neutralized in the same way as other foreign substances entering the body, passive immunity is of short duration. usually lasting only about two to four weeks. This is the serious drawback to the production of immunity of the passive variety, which otherwise possesses the very desirable features of absolute safety and immediate protection. Active immunity, on the other hand, is usually of long duration so that if a method can be found of establishing this variety without the dangers and drawbacks of a natural attack of the disease, there is an obvious advantage in its employment. The first discovery of a means of accomplishing this was made by Jenner, in 1796. This observer noticed that persons who had suffered from cow-pox, a benign eruptive disease of cattle, escaped contracting small-pox, then very prevalent in England. Accordingly he introduced the method of vaccination with the infective lymph from cow-pox lesions by which human beings are made to pass through an attack of the mild bovine form of the disease in order that thereby they may develop an immunity against the graver infection.

Although it was not until nearly a century later that any very clear ideas on the subject of immunity came to be formulated, Jenner's discovery remains the greatest therapeutic fact of all time and to this day one of the most successful methods of artificial immunization in existence.

The basis of modern methods was laid by Pasteur in 1880 when he demonstrated that the virulence of cultures of anthrax bacillus could be reduced so that their inoculation in suitable doses failed to produce a fatal attack of the disease but gave rise to strong active immunity against it. Later many other means were devised for giving active immunity against different diseases in all of which the living organisms were employed, but the danger minimized either by introducing them into a tissue unfavourable for their multiplication or by attenuating their virulence by physical, chemical or other means before inoculation. By these methods, in which living germs are injected, a fairly strong immunity can be provoked, but either on account of the very variable susceptibility that always exists among individuals of any one species, or the re-acquirement of virulence by the organisms, there is always a certain amount of danger of a fatal attack of the disease being set up in a proportion of cases. The average fatalities caused in this way may be so small as not to be worth consideration in other countries, but they are usually sufficient to prevent the adoption of such procedures in India.

More recently it has been found that a degree of active immunity can be produced by the injection of the bodies of bacteria killed in various ways. This procedure is quite free from danger and is that employed with such marked success in typhoid and plague inoculations in the human subject. The results obtained in the case of animal diseases have not been so striking but the method has been adopted in certain cases with good effect. The resulting immunity lasts considerably longer than that following the injection of anti-serum but as always occurs in active immunization there is a short period, usually three or four days with dead vaccines, following the injection, during which the animal has an enhanced susceptibility. This so-called negative phase is due to the absorption of the existing anti-bodies and lasts until the tissues have begun to produce the specific anti-bodies that afford the protection; the subsequent period of immunity is known as the "positive phase."

As a consequence of the researches of Sir A. E. Wright and others killed vaccines are now largely used in the treatment of bacterial infections, both in human beings and animals, but since the subject is outside the strict interpretation of the title of this paper, it can only be mentioned here.

What may be described as a combination of passive and active immunization has been employed with marked success in certain diseases, and is applicable to almost all those for which a strong anti-bacterial serum can be prepared. The method is termed "serum simultaneous" and comprises an inoculation first of anti-serum and at the same time or shortly afterwards an injection of a culture of the organism or of material containing it. In this way the animal is given an immediate passive resistance which prevents a subsequent attack of the disease following from the inoculation of the living germs, or so modifies it as greatly to lessen the risk of a fatal termination. In either case an active immunity is set up, the strength and duration of which depends as a general rule on the severity of the reaction produced.

Since however, it is not always possible to establish a correct balance between the amount of anti-serum and infective material required in different individuals whose susceptibilities may vary considerably, the method is not without danger and so can only be employed when the owner is prepared to take the risk, and in places where the disease already exists.

Having thus defined the general lines on which immunity to certain classes of infective disease can be established, we may now consider the individual diseases more in detail, and the first in point of importance is **rinderpest.**

The Commission appointed by Lord Mayo's Government reported in 1871 that "Rinderpest is the murrain to which a far greater share of mortality among cattle is due than all other causes put together" and this would appear to be still true at the present time.

A leader writer in the *Pioneer* of 1893, quoted by Lingard, placed the loss to stock owners caused by rinderpest at three crores of rupees in a bad year. Last year the returns of the Superintendents of the Civil Veterinary Departments for the various provinces showed that 1,10,397 bovines and 1,232 sheep were reported as having died from rinderpest, but it is certain that a large number of outbreaks still remain unrecorded: the losses occurring in the Native States are not included in these figures, but they are certainly heavy so that the total yearly deaths from this disease in India must be very great.

Much of the early investigation work on protective inoculation against rinderpest was done in South Africa by Koch, Turner, Kolle, Theiler, Edington, Pitchford and others just prior to the starting of the Muktesar Laboratory; the first line of inquiry to which the officers of that institution therefore devoted their attention was to ascertain which of the various methods put forward was most suitable to Indian conditions. At the request of the Government of India, Koch visited Muktesar in 1897 and gave a demonstration of his bile process, but after much experimental work, extending over several years, it was decided that the serum alone method was the only one which satisfied the necessary requirements for adoption in India. Serum inoculations were accordingly started in the year 1900 when 1,730 doses were issued. At first its acceptance by stock owners was slow but as its value came to be realized the demand increased rapidly. In 1904 the output from Muktesar was 56,483 doses, in 1905, 1,24,015, by 1911 it had risen to 7 lacs of doses, while last year no less than 13½ lacs of doses were supplied to India alone. At the present time the demand for rinderpest and other sera and vaccines appears to be mainly regulated by the number of qualified veterinary assistants available to carry out the inoculations in the various provinces. The staff of these is now much below requirement or even sanctioned strength, partly on account of the War and partly owing to the veterinary colleges being unable to pass out a sufficient number of graduates to fill the vacancies.

Cattle are by far the greatest sufferers from rinderpest but sheep and goats may also become affected and deaths especially in imported breeds, may be numerous. The causal agent is present in the blood and discharges of affected animals but is too minute to be visible even under the highest power microscope ; it is therefore referred to as an ultra-microscopic virus and since cultures cannot be obtained, blood from infected animals which contains the virus, is used in immunization and hyper-immunization for the production of the anti-serum.

The process of manufacture has been much improved from time to time and that which is now adopted is briefly as follows: – Bulls of the highly susceptible Kumaon breed and buffaloes are employed and are first immunized by the serum simultaneous method already referred to, by which each receives a standard dose of anti-serum and at the same time a small injection of blood from an animal suffering from rinderpest. As a result the animal passes through a mild attack of the disease and recovers in about 10 to 12 days. At the height of the reaction some blood which then contains virus is taken for hyper-immunizing other serum making animals. A week after complete recovery the animal is bled once for serum and a few days later receives an injection of from one to two litres, according to its weight, of a mixture of virulent blood and potassium citrate solution, the latter being added to prevent clotting and aid absorption of the blood. On the 8th, 12th and 16th days after the injection the animal is bled for serum, the amount taken being regulated according to the weight and condition of the animal. After a rest of a week or more the animal is again injected with virulent blood and then bled as before, these processes being repeated as long as the animal absorbs the injections completely. The frequent bleedings cause little or no interference with the general health of the animals. The serum is separated from the blood either by centrifuging or clotting; a modification of the latter method has recently been introduced by which an increased yield is obtained. When about 600 litres of serum from various bleedings and animals have been prepared, the whole is mixed and tested in graduated doses on susceptible hill bulls. In this way the strength of the serum is ascertained and only that is issued which will protect against an injection of virulent blood in doses of 72 c.c. per 600 lb. body weight in the case of hill bulls. This is equal to 4 c.c. per 600 lb. in plains cattle; smaller doses are usually sufficient to prevent a fatal attack in the test animals but in order to provide a margin for safety the standard dose issued is 5 c.c. for plains animals. As however the susceptibility of plains animals varies considerably this dose may with advantage be increased in those outbreaks in which a high mortality indicates low resistance to the disease.

As has already been explained, the serum gives an immediate passive immunity lasting about two to three weeks or longer if the dose is increased. This would seem to be of little practical value but actually it is found to fulfil requirements in the majority of outbreaks at the present time. All that can now be attempted is to check the mortality in places where the disease is active and prevent, if possible, an extension of the infection; accordingly, the still healthy cattle in the neighbourhood receive an inoculation of serum and are then allowed to mix with the sick or graze over infected ground. In this way a good proportion of them pass through a mild attack of the disease and develop an active immunity of long duration. To all intents and purposes this is a natural method of serum simultaneous inoculation, natural infection taking the place of the injection of the virus. It is not so reliable but is not open to the same objections as the double inoculation and in practice is found to give satisfactory results. The treated animals that do not become infected are nevertheless protected for a sufficient time to allow of the sick animals either dying or recovering, thus getting rid of the source of further infection. A few deaths after serum inoculation are usually reported but last year the returns show that these amounted to just 0·4 per cent. of the treated animals* and in a considerable

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* Rinderpest in 1914-15, Reports of Civil Vety. Dept.

Number of deaths before inoculation	44,450
Number of animals inoculated	4,39,470
Number of deaths after inoculation	1,765

proportion of them the disease was probably well established before serum was given so that the actual number not immunized must be very small. Anti-rinderpest serum has very little curative effect once symptoms have developed.

In the case of cattle the property of Government or of owners who are prepared to take the risk of a small mortality in order to have all their cattle actively immunized, the most satisfactory method is the 'serum simultaneous.' It may be carried out before the disease has made its appearance, thus avoiding any initial loss, and with proper precautions there should not be any mortality from the inoculation; the immunity given will be of long duration. The necessary requirements are actively virulent blood and anti-serum of accurately determined potency in properly regulated doses. The first has always been considered difficult to obtain in the absence of the close proximity of the disease as past experience has shown that in the plains of India the virus quickly perishes in drawn blood and so cannot be transported from a distance with any certainty.

Recent investigations, which are still in progress, have shown that two essentials for preserving the rinderpest virus in drawn blood are a low temperature and the taking of the blood early in the attack, that is, at the time of the first marked rise in temperature, before any development of anti-body has occurred. The exclusion of air or oxygen is also an advantage. When these conditions are fulfilled, there appears to be no difficulty in preserving the virus for weeks or even months.

The method of testing the potency of the serum has already been explained; the fixing of the correct dosage can only be effected by observations on small numbers of each of the different breeds or classes of animals to be immunized. This is particularly necessary in the case of imported pedigree or half-bred stock which have a high susceptibility to the disease. By commencing with large doses of serum and gradually reducing them in subsequent tests such determinations could be made without serious loss.

There is evidence to show that even when the dose of serum is so large as to prevent any reaction resulting from the virus *inoculation, a degree of active immunity is nevertheless established, but it is doubtful whether this is of long duration.*

While undergoing immunization the cattle must be strictly isolated as during the reaction they are capable of transmitting the disease to healthy stock, and subsequently the sheds in which they have been kept, should be thoroughly disinfected.

Hæmorrhagic Septicæmia is an acute, rapidly fatal disease affecting essentially bovines though horses and elephants sometimes become infected. During 1914-15, 3,395 deaths from this disease were reported, but the actual number is undoubtedly much greater.

The causal bacillus can live in moist soil and is probably very widely distributed. Outbreaks of the disease are most frequent during and after the rains when the conditions are favourable for the multiplication of the organism and the excessive moisture reduces the vitality and resistance of the animals. During drought also the disease may occur; scarcity of food then weakens the cattle and renders them more susceptible to the infection, which they probably obtain from drying-up tanks and river beds. Once the disease has started, it may spread by direct contagion but seldom assumes the epizootic character of rinderpest. It runs a very rapid course, death usually occurring two or three days after infection in a large proportion of the animals attacked.

Lingard first prepared an anti-serum against this disease in 1905, by the injection of small doses of culture of the organism into cattle. Holmes greatly increased the strength of the serum by employing larger injections of culture. A considerable number of doses at 5 c.c. each were issued between 1905 and 1908 but early in the latter year its use was discontinued as the protection given was considered to be too short for practical purposes. In 1910 Holmes introduced the stronger serum at 15 c.c. per dose and the demand rapidly increased from 1,800 doses the first year to 77,328 doses in 1914-15. This figure has already been exceeded during the first nine months of the current financial year.

In dealing with outbreaks of the disease the animals exposed to infection are inoculated with anti-hæmorrhagic septicæmia serum; this gives them an immediate passive immunity lasting for three to four weeks, by which time the sick animals have usually either died or recovered. The disease not being as readily conveyed by contagion as rinderpest and its course being more rapid, there is not the same likelihood of producing an active immunity by the mixing of inoculated with sick animals, so that no lasting protection results in most cases. Active immunity may be obtained by a serum simultaneous inoculation, a small dose of culture of the organism being given shortly after the serum. Owing to the great variation in susceptibility of different individuals it is difficult to fix accurately the dose of serum necessary to control the reaction caused by the injection of culture so that a small percentage of losses must be expected. For this reason also the method should not be adopted in areas free from infection.

A serum simultaneous inoculation is employed at Muktesar to first immunize the hili bulls and buffaloes from which serum is to be obtained. Then, at intervals, after recovery from the first reaction, the animals receive gradually increasing doses of virulent culture of the organism, injected subcutaneously, until they are highly immune and can tolerate the injection of 1 litre or more of a broth culture. They are bled three times for serum and again receive culture in still larger doses, the subsequent bleedings and injections following each other as in the preparation of other anti-sera.

In certain districts hæmorrhagic septicæmia appears with such regularity at particular seasons of the year, that a safe method is required of giving a more lasting immunity than serum can confer, to be applied before the disease has actually broken out. To meet this need as far as possible, a vaccine containing only killed organisms was prepared in 1908; since its introduction the demand has rapidly increased until in 1913-14, 2,40,000 doses were issued. It is perfectly free from danger and in doses of 5 to 10 c.c. provokes a degree of active immunity which lasts several weeks. Owing to the fact that a " negative phase " of about four days' duration follows the inoculation, vaccine should not be made use of when the disease is already active, otherwise deaths are likely to follow.

Experiments are now being carried out with the view of lengthening, if possible, the period of immunity that can be produced by dead vaccines but the great susceptibility of cattle, and especially of buffaloes, makes this extremely difficult of accomplishment by means of a single inoculation.

True anthrax is responsible for a large number of deaths yearly in cattle, horses and sheep, but outbreaks are usually sporadic and the infection does not spread rapidly among the animals of a particular locality. Occasionally, however, a considerable number may become infected from one source at the same time. As with hæmorrhagic septicæmia the bacillus lives in the soil and in some districts is more prevalent during and after the rains. Most animals are very susceptible when inoculated with a small amount of culture of the bacillus and a high percentage succumb but the native breeds of cattle are curiously resistant to this form of the disease unless their vitality has been reduced by some means. Subjection to unfavourable conditions also probably plays a considerable part in aiding natural infection by anthrax, just as it does in hæmorrhagic septicæmia.

As already mentioned, Pasteur was the first to confer artificial immunity against anthrax on animals; this he did by means of cultures of the organism attenuated in virulence by growing in oxygen at high temperatures. He employed two vaccines, the first being more weakened than the second, and these were injected at an interval of ten or twelve days. Although largely used on the Continent at the present time, the results obtained with Pasteur's vaccines have not always been favourable, and in most other countries their employment is strongly discouraged. Several modifications of Pasteur's method of attenuating the cultures have since been practised but these in common with the original vaccines have the following objections :—The immunity resulting is variable and uncertain, deaths from anthrax following the use of the vaccines, especially the second, are not infrequent and the danger of disseminating the disease in this way is by no means negligible. In horses and sheep the vaccines are unsafe and considerable mortality sometimes follows their injection. For these reasons attenuated vaccines are very unsuitable for use in India, though, as previously stated, they were not the ones put forward when the Government decided in 1900 to have nothing further to do with the Pasteur vaccines.

Anti-anthrax serum was first prepared by Sclavo in 1895 and subsequently by several bacteriologists but no very extensive use appears to have been made of it for the protection of animals.

Lingard introduced anti-anthrax serum in India in 1902. He prepared it from cattle by repeated inoculations of living culture of the organism in a similar manner to that described for the production of hæmorrhagic septicæmia serum. Large amounts of anthrax serum were employed in the field during the years following its introduction up to 1908, but it was then found that a large number of deaths attributed to anthrax were actually caused by the organism of hæmorrhagic septicæmia and accordingly its use was restricted to outbreaks in which the diagnosis was confirmed microscopically; at the same time the issued dose was increased to 15 c.c.

In 1913-14 the demand increased to over 20,000 doses, and last year showed a further slight increase; in the earlier part of the current year anthrax was very prevalent and over 40,000 doses have been issued during the past nine months to all parts of India.

Serum injections are carried out on cattle that are actually exposed to risk of infection in places where one or more deaths from the disease have occurred. Protection is given for three or four weeks only but this checks the immediate spread of the disease and allows the source of infection to be dealt with by disinfection or other means. If necessary the inoculation of serum may be repeated. For the treatment of anthrax in man, anti-serum has given very good results, and where opportunity offers, could be similarly employed in the case of animals; unfortunately the disease is usually so rapidly fatal that death occurs before treatment can be applied.

In places where anthrax frequently appears and the owner is prepared to accept the risk of a few deaths from the inoculation, an active and lasting immunity may be produced in cattle by the "serum simultaneous" method, using either virulent or attenuated culture at the same time as the serum. Owing to their great susceptibility this method is too dangerous in horses and sheep. Experiments are now in progress in which killed cultures are being tested as to their immunizing value. These are free from risk but it is not yet certain that a useful degree of active immunity can be induced by their means.

Another seasonal and sporadic disease of cattle and sheep formerly confused with anthrax but caused by a distinct organism, is **black quarter** or **quarter evil.**

The French name, charbon symptomatique, is also sometimes used, but since this serves to perpetuate the old confusion with anthrax, of which the French name is charbon, it ought to be dropped, and one of the more accurately descriptive English names adopted.

The black quarter bacillus can also exist in soil and on gaining entrance to the body, developes in the muscles, usually of the hind quarter, causing local symptoms and rapid death in the great majority of animals becoming affected.

A serum for this disease can be prepared, but as it only affords protection for a short time and the spread of the infection by direct contagion is of infrequent occurrence, it possesses little practical utility.

In most countries vaccines, prepared according to the original method of Arloing and Corniven or some modification of this, are employed and give highly satisfactory results. As the causal bacillus is found in great numbers in the affected muscles of animals which die from the disease, this tissue or the juice expressed from it, is employed in the preparation of the vaccines.

By Arloing's method a first and second vaccine are prepared by heating the dried muscle at definite temperatures for a short period ; greater heat being applied to the first than to the second ; in this way the organisms in the first vaccine are more attenuated than in the second and each is inoculated separately at an interval of ten days.

Vaccines made according to this method were first issued by Lingard in 1906, but owing to the necessity for two operations the demand was not large.

Holmes in 1909 tested a single vaccine made by mixing in fixed proportions first and second vaccines, prepared somewhat after the method of Arloing. This gave very satisfactory results, and the average yearly issues since its introduction have amounted to nearly 16,000 doses.

To simplify its inoculation the vaccine is supplied in the form of a pillule which is inserted under the skin by means of a special injector. In as much as the vaccine contains living, though weakened organisms, its use is not always free from risk, but in practice the deaths have been so rare that no objection to the inoculation has been raised on account of them; last year out of 4,902 cattle inoculated only 10 or 0·2 per cent. subsequently died of the disease either as the result of the injection or owing to its failure to give immunity. As the disease is not transmitted by direct contagion to any extent there is little danger of introducing it by the vaccination although this is only recommended in places where the disease is known to have already occurred.

An active immunity lasting at least several months is established, and since young animals are those most susceptible, one inoculation will usually carry them over the most dangerous period of their lives. In badly infected districts the injections may be repeated each year.

The sera and vaccines already referred to are used almost entirely in outbreaks of disease in bovines; the majority of diseases of horses and sheep in India either do not lend themselves to protective inoculation, as with surra and glanders or such cannot be attempted owing to our ignorance of the causal agent itself, as is the case in *kumri* and several other local diseases of stock not yet investigated. There is reason to believe that some of the latter class are caused by plant or other poisons and not by micro-organisms, in which case protective inoculation can hardly come into operation to aid in their prevention.

The only purely equine disease for which protective agents are issued from Muktesar, is **strangles**. As a general rule, this disease does not call for prophylactic measures in India, but in the Government Remount Depôts the losses and trouble caused by it are frequently very considerable. This is especially so in the country-bred depôts where large numbers of yearling horses are collected together; here the chances of infection are great and the young animals show a marked susceptibility.

Since 1909 anti-strangles serum has been prepared by the injection of horses, mules and cattle, with increasing doses of culture of the causal organism, the *streptococcus equi.* In other countries similar anti-sera have been said to confer protection against the disease, but in these the age at which the horses are most liable to infection is four to five years, whereas in the Indian depôts they come in at 11 to 13 months old and are under the disadvantage of having just been weaned. At all events in these young animals anti-strangles serum has unfortunately been found to give very little protection although in the treatment of the disease its use is of marked benefit. At present it is chiefly employed as a curative agent.

Experiments are now in progress with various dead and living vaccines of the organism, and it is hoped that some means will be found of conferring a sufficient degree of immunity upon the young stock, on entering the depôts, to carry them over their most dangerous period.

In India **tetanus** is very widespread, and any of the domesticated animals may become affected, but the great majority of cases are seen in horses. The tetanus bacillus gains entrance to the body through deep wounds and produces its effect on the animal body by means of the toxin which it forms in the wound and which becoming absorbed acts on the nervous system. By obtaining this toxin from cultures of the bacillus and injecting it in gradually increasing doses into horses, a strong anti-toxic serum can be prepared. This when injected into an animal in suitable dose protects it against infection by the organism for a period of three or four weeks. It is employed chiefly on horses that have contracted penetrating soil infected wounds, in the same way that it is injected into wounded men at the front, to prevent the development of any tetanus germs that may have entered. It is also given in the treatment of cases of the disease but the benefit derived is not always very marked, either in man or animals.

Anti-tetanic serum was prepared at the Muktesar Laboratory in 1906, but as the demand was too small to justify the expense of its manufacture, this was discontinued the following year; the product of various reliable English and American firms can be obtained on the Indian market.

Once the value of a biological product in the prevention or cure of a disease has been demonstrated, there is a common tendency for inexperienced persons to form an exaggerated idea of the effects and possibilities of the agent; to avoid disappointment it is necessary, therefore, to emphasize that all methods of establishing immunity are liable to break down in a proportion of individuals whose susceptibility is abnormal. What is aimed at is to give as strong and lasting an immunity as the limitations of Indian conditions will allow, and the periods of protection stated for the different sera and vaccines apply to the normal animal, but in all cases a few individuals will be found in which it will be either shorter or longer, according as their susceptibility is greater or less than the average. The importance of such adverse circumstances as fatigue, hunger, drought, cold and rain, in predisposing stock to diseases has already been mentioned and these may be sufficient to break down in some cases the additional resistance conferred by inoculation so that in estimating the value of any particular agent they should not be forgotten.

That inoculation of stock should have extended in India during recent years with the rapidity shown by the increasing demand for sera and vaccines, and in spite of the obvious difficulties of securing its voluntary acceptance, is a tribute not only to the value of the agents themselves but also to the energy and perseverance of the Veterinary Department, on whom the task of gaining the confidence of the stock owners rests.

There can be little doubt that as knowledge spreads the importance of guarding their animals against disease will become more widely recognized by Indian stock owners and protective inoculation will-contribute to a still greater extent towards the agricultural prosperity of the country, which depends so largely on the maintenance of the health of its live-stock.

NOTE ON SOIL DENUDATION BY RAINFALL AND DRAINAGE: CONSERVATION OF SOIL MOISTURE.*

BY

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THE question of soil erosion in India in most of its aspects has been discussed recently by the Imperial Economic Botanist, and this note is submitted only because it contains a few observations on the way in which soil erosion is dealt with in a neighbouring country where the problem is of great importance and in many respects similar, and because it may help to identify the agriculture of tea with that of other crops in India in respect of the necessity for improving existing methods of prevention of loss of soil by wash. Although there are many features of tea cultivation which make tea a thing apart from other agricultural operations in India, this is a point where the interests of tea planters are identical with those of other agriculturalists.

The retention of soil on sloping land by prevention of wash is of considerable importance to the tea industry of North-East India not only in Darjeeling, where land slopes very steeply, but in other parts of the tea districts where estates are generally fairly level.

The conditions under which soil erosion takes place in the different tea districts of North-East India may be described as follows:—

In Assam tea land is usually level but it is intersected by *hullas* or *nullahs* (natural depressions which take off surface drainage), some of which are filled with jungle, while rice is grown in others. Tea which has been planted for many years on the edges of such *hullas* shows in most cases unmistakable signs of having suffered from the soil erosion which has taken place.

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* A paper submitted to the Board of Agriculture in India, 1916.

In the Dooars tea land consists of a bank of heavy loam extending several miles from the foot of the Himalayas southwards towards the plains and below this of level land, the soil of which is in most places grey and sandy. There is a definite drop of a hundred feet or more from this red bank to the plain below and similar breaks occur at places in the red bank itself. The tea land of the Dooars is intersected by rivers which flow directly from gorges in the hills, and in time of heavy rain these are rapidly flowing torrents ; in the cold weather they are almost dry. These rivers often alter their line of flow and tea consequently is not usually grown near their banks. In many places near the hills the surface of the stiff red clay loam is undulating. It is on this red bank that the most serious problems of soil erosion have to be faced, and, with a rainfall sometimes as high as 200 inches per annum, and confined chiefly to a few months in the year, the loss by wash is considerable. The fertility of this red soil suffers very seriously when wash has taken place.

In Cachar and Sylhet a particular feature of tea lands is the presence of steep rounded *tilas* (low hills projecting from the level plain) interspersed among flats of different and more recent soil. The *tilas* are sometimes quite sandy, sometimes gravelly, but often of fairly stiff clayey soil. The soil of the flats ranges between a heavy intractable clay and a coarse sand, poor chemically. A special type of such flats are the drained *bheels* (peat bogs) in which the percentage of organic matter may range between 15 and 70 per cent. The prevention of soil erosion is of particular importance in this district in connection with the loss of the fertility of the *tilas*.

In Darjeeling the soil at higher elevations usually consists of a heavy reddish clay and that at the highest elevations is overlaid by a fairly deep humus layer and wash is not very serious. At medium elevations this clay suffer from wash and the fertility of the land has consequentl deteriorated. At medium elevations also some ver sandy soils occur and these have suffered very considerably from wash. At lower elevations near rivers wher the land is less steeply sloping some rich alluvial sand stretches are found which have been formed at the expens of the fertility of the ridges and hill sides above.

Throughout the tea districts, with the exception of a few garden in Darjeeling and on some of the *tilas* in Cachar and Sylhet, th arrangement of tea bushes is in square or triangular alignment and in solving the problem of protecting estates from loss of fertility b soil erosion, the treatment of considerable areas of old tea, plante in this manner (a most objectionable one on land where seriou loss of soil by wash is likely to take place) many years ago, has to b considered, in addition to devising the best means of laying out an planting such slopes on land which is being put under tea for th first time.

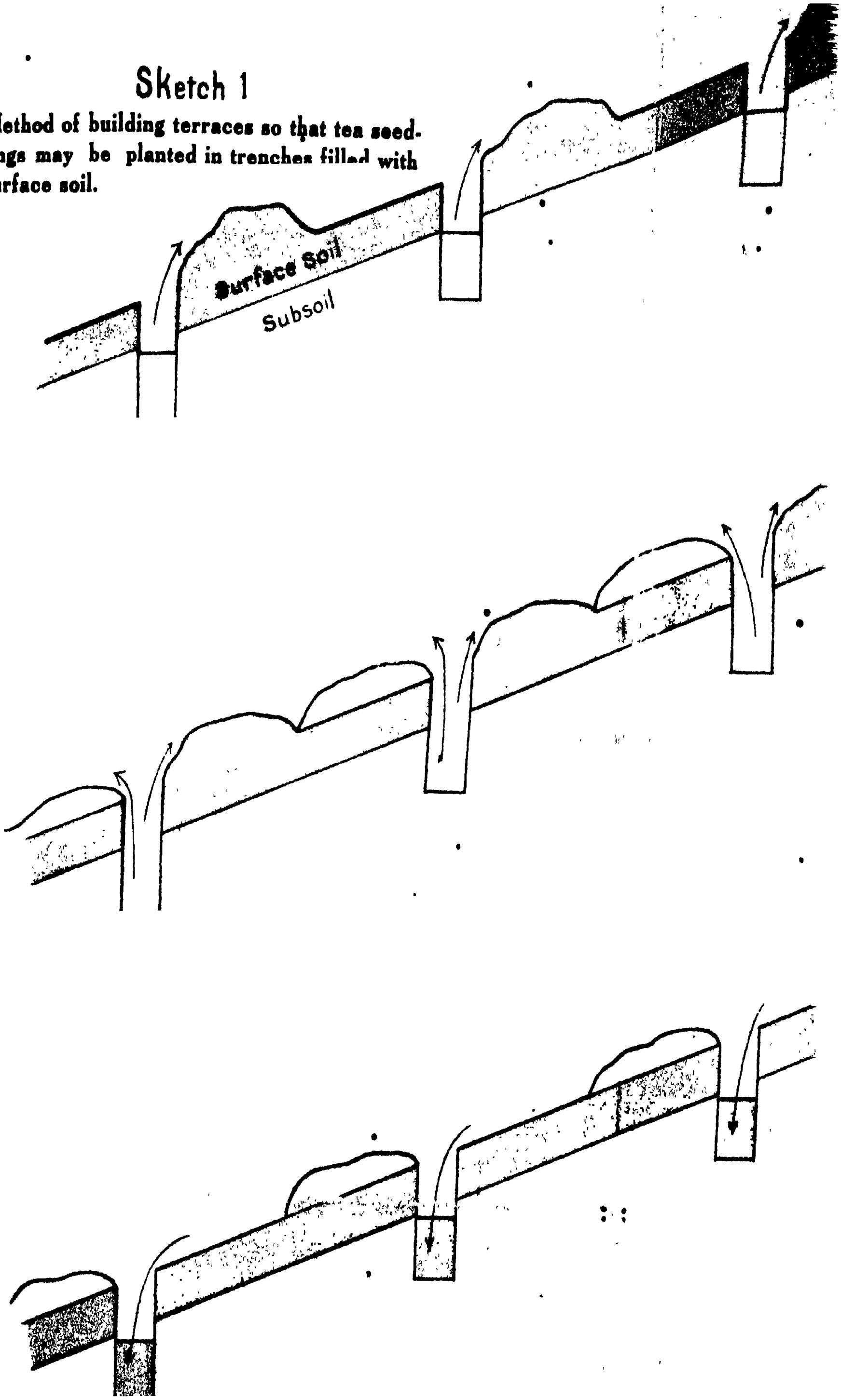
At the end of the year 1913 the writer spent some weeks i Java and Sumatra and was much impressed by the means whic are taken in these countries to prevent loss of surface soil by wash on tea estates as compared with the efforts made to this end in Ceylon and North-East India.

The whole of the tea districts of Java are sloping land, and it is the invariable custom to plant tea fairly closely on contour lines as distinguished from square or triangular arrangement, the result being that in no cases are there spaces between the bushes in straight lines of any length down slopes such as can be seen on every tea estate in Ceylon and on many estates on sloping ground in North-East India where the planting is in square or triangular alignment. Contour planting is undoubtedly the better method whenever there is possibility of serious erosion.

This being the first step taken by Java planters, other means are adopted according to the nature of the land, and these consist in terracing, where the land is steeply sloping, and in arranging a system of contour drains, contour hedges of suitable leguminous

Sketch 1

Method of building terraces so that tea seedlings may be planted in trenches filled with surface soil.



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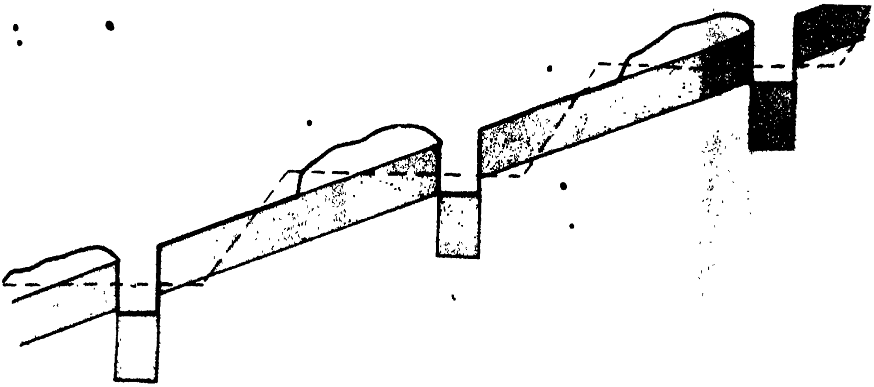
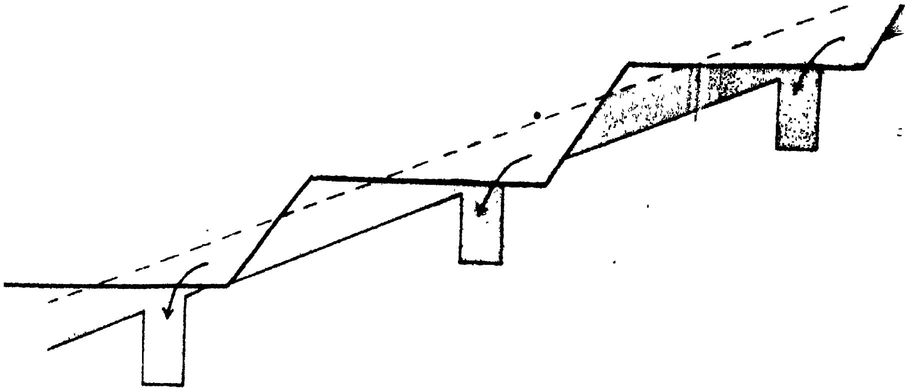
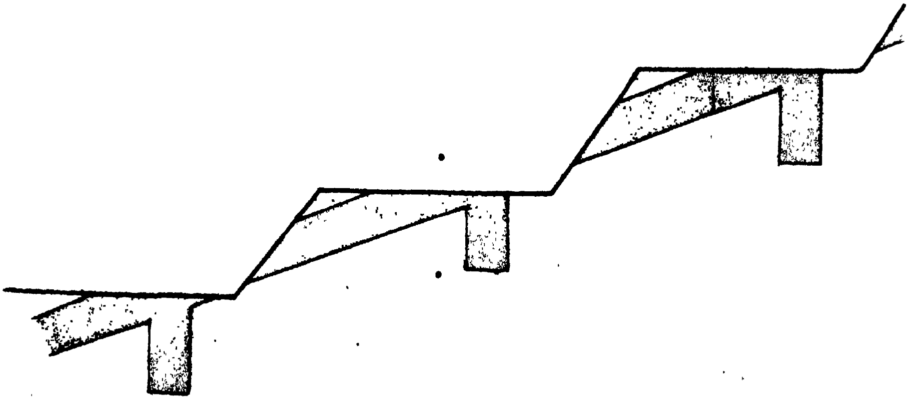


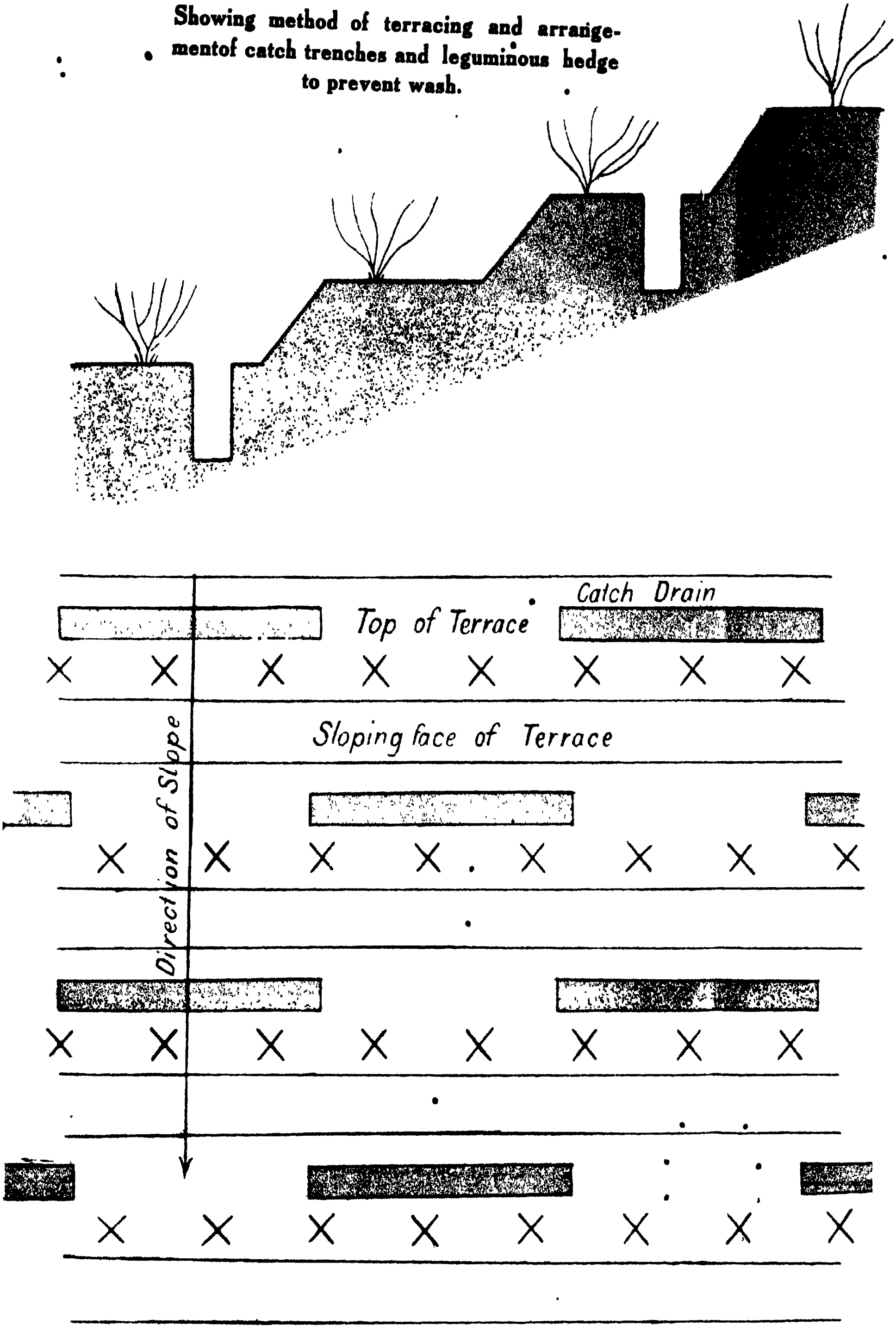




system of contour drains, contour hedges of suitable leguminous

Sketch 2 *Plan & Elevation*

Showing method of terracing and arrangement of catch trenches and leguminous hedge to prevent wash.



system of contour drains, contour hedges of suitable leguminous plants, and series of catch-trenches in contour alignment, in less steeply sloping situations.

Opinions differ in different parts of the world as to the value of terraces, a fact which seems to indicate that there may be some factor as yet not fully understood which accounts for terraces being of use in some places while in others their value appears to be doubtful. In Ceylon tea estates terraces are rarely seen in spite of the fact that much of the tea land is more steeply sloping than on most estates in Java. It is surprising that in Ceylon the terracing which is so picturesque a feature of the journey from Colombo to Kandy has not been copied on tea estates and the omission has undoubtedly been an error in judgment though it has been a still greater mistake to have adopted linear instead of contour planting on sloping ground.

In Java, certainly, nearly everyone is persuaded of the value of terraces on steeply sloping ground.

Opinions differ in Java as to whether terraces should be made before the tea is planted or afterwards. The argument in favour of making the terraces before planting the tea is that the work can then be done carefully and completely without any disturbing factors, and, being done, is done once for all, and when the tea is eventually planted it merely remains to adopt an efficient system of keeping terraces in order. Those who are in favour of making the terraces after planting out the tea base their argument on the fact that in such cases the tea is planted in surface—and not in sub-soil, and that if the weeds, when they are gathered, are regularly placed between the rows of tea, planted in contour lines, terraces form of themselves and are in all respects as efficient as those made more expensively before the planting out of the tea. It is possible however to make terraces before the tea is planted out, in such a way that the seedling plants are planted along the lines of trenches which have been filled in entirely with surface soil, and it is more satisfactory from several points of view to make terraces before the seedlings are planted. (Sketch 1.)

Terraces having been made the upkeep of them is a matter of great importance. In Java many different plants are used to protect the edges and faces of terraces and are either planted there directly, or, if of naturally occurring species, are encouraged to grow in preference to other plants by a process of selective weeding of the terrace faces. Species of *Hydrocotyle, Viola, Desmodium,* etc., are commonly seen grown in this way.

On fairly broad terraces it is often the custom to dig short trenches at intervals along the inner edge of each terrace and these serve to catch the wash which comes from the terrace above. These catch-trenches are cleaned out when the terraces are weeded, and the earth which has collected in them is thrown up onto the terrace above. (Sketch 2.)

The system is an excellent one under Java conditions where weeding and forking, instead of hoeing, is the method of cultivation.

A similar system of catch-trenches is employed largely in cases where the land is not steep enough to terrace. The method then generally adopted is one of alternate contour lines of catch-trenches and of green crops, sometimes with one and sometimes with two lines of tea between them. In such cases the positions of the catch-trenches, which are usually about 12 feet long by 1 foot broad by 1½ feet deep, alternate with 12 feet intervals along the contours, and are arranged in echelon with those next above or below along different trenched contours, so that if any earth is carried beyond one line of catch-trenches and past the intermediate tea bushes and green crop hedge, it will eventually be caught in the next catch-trench below. (Sketch 3.) When these catch-trenches are cleaned out, which is usually done at the time of weeding, the earth is thrown up the slope.

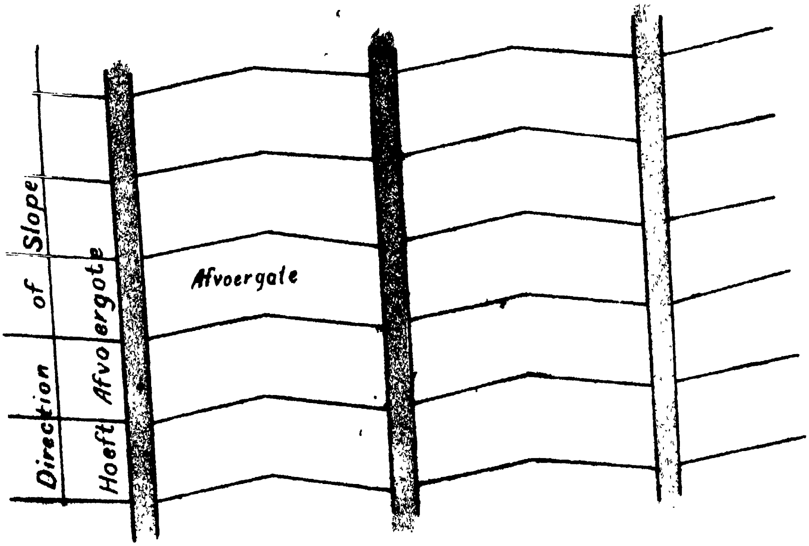
Leguminous plants such as *Leucaena glauca, Clitoria cajanifolia, Tephrosia purpurea,* etc., are the plants most commonly used for the hedges which alternate with the catch-trenches.

Combined with this is a careful system of drainage.

The main drain system—it must be remembered that almost without exception fairly steepy sloping ground is under consideration—consists of "hoeft afvoergoten" (main drains) which lead directly down the slopes. It is considered most important in connection with the drainage system to remove as far as possible the excess water which cannot sink into the ground sufficiently rapidly in case of heavy showers.

ch 4

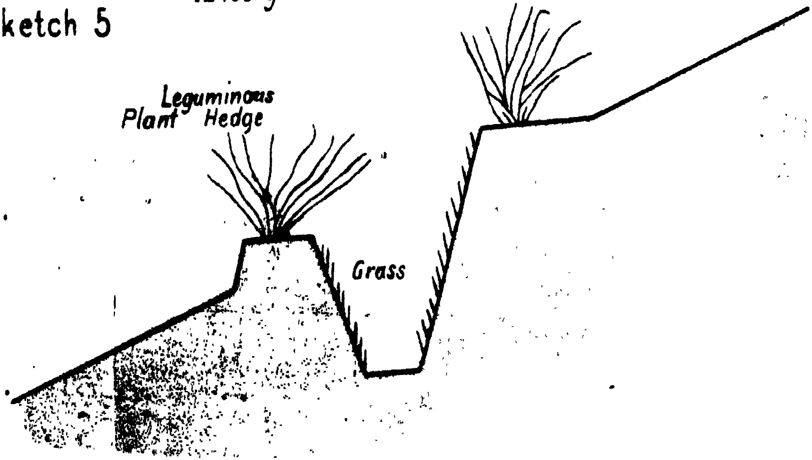
Diagrammatic Plan of Drainage of a Slope



Drainage of a slope.

Elevation
Afvoergote

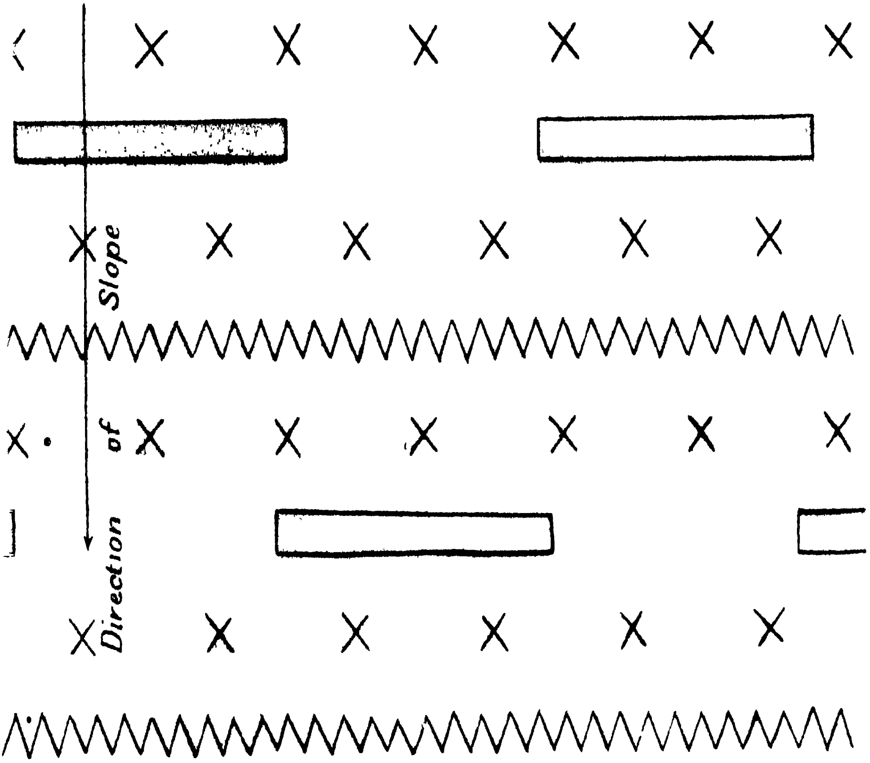
Sketch 5



Sketch 3

PLAN

Showing arrangement of catch trenches and leguminous hedge on unterraced ground.



References

X = Tea Bush

ꟿ = Hedge of Leguminous Plant

The soils of Java are very porous and when slight showers fall the rain sinks rapidly into the ground, but the soil is also very rapidly washed down by water flowing over the surface of the ground, if all the rain water is not immediately removed when heavy rain falls. This is at once the advantage and the danger of the soil of Java.

To prevent this loss by wash, it is considered of primary importance to have an escapement for excess water, and the main drains straight down the slopes serve this purpose best for they ensure the rapid removal of water at places which are chosen for the purpose, and not at places where the rush of water may do damage.

The best situations for some of these drains are the places where there are natural gullies down the concave folds of the hillsides. Where these gullies are pronounced in character one usually finds either rocky ravines, or rather water-logged patches filled with deep rich soil which has been carried there by wash before the opening up of the land. The stone ravines can be used as drains without much being done to them. They are straightened and cleaned out to some extent to facilitate the rapid removal of water. Gullies which are filled with deep earth, when drained, add to the area on which tea can be planted. The sides of these drains are protected by growing grass on them and the rush of water down them is stopped by a series of low barriers of stones, bamboos, etc. A certain number of "hoeft afvoergoten" have also to be made at intermediate positions between the gullies, and the distance between two "hoeft afvoergoten" is usually not more than 100—200 yards.

The collection of the water into these main drains is carried out by means of contour drains called "afvoergoten" and these are usually made with a very slight gradient, the object being merely to catch the water and remove it into the "hoeft afvoergoten" or main drains. These "afvoergoten" are laid out very carefully on Dutch estates in Java, and are flanked on the upper and lower sides by banks on which suitable leguminous plants are grown. Grass is often grown on the sides of the drains themselves. Drains are cleaned out periodically, for the danger of water breaking through must be carefully avoided since it would cause great damage because it would mean the escapement of water down hill at a point for which preparation for its control had not been made. (Sketches 4 and 5.)

Modifications of one or other of these methods is the system adopted in Java for the prevention of wash, and on some of the new tea estates which are being started in Sumatra.

There is some difference of opinion in Java as to the extent to which cultivation is a factor in aggravating loss of surface soil by wash. Some claim that if soil be cultivated at times of the year when there is much rain, the rain, instead of washing the soil with it down the slopes, sinks into the ground and thus wash would be prevented. Others say that if the soil is undisturbed, and particularly if it be protected with a slight covering of jungle, wash will be inappreciable whereas it will be considerably greater if the soil has been recently cultivated and is broken up and free of jungle growth. Very much depends on the nature of the soil and this is a subject which might receive study in connection with loss of soil by wash in India : that is to say, it would be worth while to determine, in districts where loss of surface soil by wash is known to be great, the effect of cultivation in aggravating or reducing the amount of wash and to correlate this information with data bearing on the mechanical composition and physical properties of the soil.

There is another point which has so far been left out of discussion on the subject of soil denudation in India and that is the extent to which dry wash—that is, movement of particles of soil down hill in dry weather as the effect of wind—takes place. In Java, this dry wash takes place chiefly at medium elevations where the soil is loamy in character but is of sufficiently good tilth to pulverize on the surface in dry weather. The compact soil immediately below the loose layer on the surface affords a comparatively smooth plane down which detached particles of surface soil are blown by wind. These particles collect behind tea bushes and stones and on the flat faces of terraces and are washed down in the form of mud by the first heavy shower of rain.

The extent of the loss of soil which is going on steadily this way in dry weather is undoubtedly very great in some districts of Java, and it would be interesting to determine whether a similar phenomenon takes place to any great extent in India and in what localities it occurs particularly.

Speaking of tea planting only it may be said that the methods employed in Java appeal to the writer as being unquestionably the best that can be done to prevent loss of surface soil, and although it is a matter of great expense and trouble, yet, where tropical agriculture is becoming yearly more intensive and new land cannot be obtained to replace by new clearances the older parts of existing estates, all that can be done to prevent loss of surface soil on existing estates has a very great commercial value.

The adaptation to the conditions which obtain in the tea planting areas of India, of Java methods should receive careful consideration.

The present measures adopted for the prevention of wash in the tea districts of Ceylon and North-East India appear to be largely wrong or inadequate.

SPRAYING FOR RIPE-ROT OF THE PLANTAIN FRUIT.

BY

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First Assistant to the Imperial Mycologist.

THE plantain fruit is often affected by a ripe-rot caused by a fungus, *Glœosporium musarum,* chiefly during the rains. This disease is common wherever plantains are grown. It is confined to the fruits and the fruit stalk.

In India, as far as the writer is aware, it is chiefly a disease of the stored fruits ; but it is also found on very young fruits though fortunately, not often. The presence of the fungus on mature fruits is marked by the appearance of a small black circular speck on the peel. This rapidly increases in size, becomes depressed and in this sunken area are found pink concentric rings which look moist and bright when fresh on account of the presence of oil globules. These concentric rings are the spore beds (" ascervuli ") of the fungus. There are generally more than one such diseased areas which merge into one another and eventually cover the whole fruit. The effect of the disease is to ripen the fruit prematurely and this in its turn accelerates the rot. When the young " fingers " get infected, the infection is generally found to begin from the distal end, possibly arising through the flowers. The infected " finger " begins to turn black and shrivel from the distal end ; as the infection progresses the whole " finger " turns black, shrivels, and becomes covered with the pink spore beds of the fungus. The attack rapidly spreads and involves the whole bunch. The fruit stalk also gets diseased but the infection does not spread to the " hands " through the stalk.

This disease is of annual occurrence during the rains. In the absence of the perfect stage of the causal fungus (the perithecial stage containing the ascospores, or winter spores, which has not

A diseased plantain fruit.

yet been found, though this disease has been investigated by so many workers), the question naturally arises how does the fungus ensure its annual occurrence. It has been found in nature to produce *only one kind of spores and they are thin-walled, individually not capable of resisting unfavourable conditions. If the spores are* sown in a drop of water they readily germinate in a short time, but if the drop of water in which they are sown is allowed to run dry and after a short time the spores are resown in water, they are found to be dead. On the other hand, if the spores *en masse* are allowed to remain in their ascervuli they have been found to germinate after nine months. The ascervuli, which when fresh are moist and bright pink in colour, become dry and dull light pink after some time ;

The fruit bunch on the right was sprayed with Burgundy mixture ; the one on the left was not sprayed. Both are of the same age.

they are then found to be covered by a dry crust which keeps the enclosed spores in a compact mass and protects them from unfavourable conditions. When a drop of water is added to this spore mass it breaks away, setting loose the spores which are capable of germination. Diseased parts of the fruit stalk and diseased fruits were kept along with dried plantain leaves in an open basket on the working bench in the laboratory in September. Spores from the diseased parts thus preserved were sown in water in June.

nine months later. The spores germinated, though of course the percentage of germination was not very high. It is probable that in nature also the spores remain thus preserved on the plantation and during the rains the spore masses break up, the spores get disseminated and infect healthy fruits.

This fungus has been found to be a wound parasite, *i.e.*, it attacks the host only through wounds or abrasions on the surface.

Since 1912 this disease has been under study with the object of finding some remedial measures for its prevention. Freshly picked mature green fruits have been dipped in different strengths of copper sulphate, formalin and corrosive sublimate for varying lengths of time without any success. In passing it may be noted that unripe fruits treated with formalin ripened earlier than those of the same bunch treated with other fungicides or the untreated ones kept as controls. Spraying the fruit about two months old once every fortnight till mature with Burgundy mixture or Ammoniacal copper carbonate also failed.

It was soon found that treating the fruits when picked or when half-grown was useless. Fruits picked from bunches which were only half-grown and looked outwardly quite healthy, and which were sterilized by washing them in corrosive sublimate for five minutes gave *Glœosporium* pustules on incubating them under asceptic conditions. The pulp removed asceptically from green and unripe fruits remained sterile on incubation but the peel from the same fruit, sterilized by dipping it in rectified spirit for a minute and then flamming off the spirit, occasionally gave *Glœosporium* pustules when incubated in sterilized moist chambers. These results show that the fruit can be attacked long before it gets ripe and before the disease becomes outwardly visible, but the fungus remains dormant in the peel till suitable conditions arise for developing its activities. Shear and Mrs. Wood,[1] who also have found dormant infections of *Glœosporium* and *Colletotrichum* present in many instances in leaves and fruits showing no external signs of the disease, give a very probable explanation. The conidia germinate whenever they come in contact with the plant surface under favourable conditions and produce appressoria; these are thick-walled bodies which are capable of enduring more unfavourable conditions than the thin-walled conidia or spores. These appressoria send germ-tubes through the epidermis, in the case of the banana fruits possibly through the wounded surface, as the fungus has been found to be a wound parasite only. The germ-tube apparently penetrates at first but a very short distance, does little harm to the host cell and remains in an inactive condition till favourable conditions for its further development, such as the weakening of the vitality of the fruit or excessive humidity, arise.

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[1] Shear, C. L. and Mrs. Wood, A. K.—Studies of Fungus Parasites belonging to the Genus Glomerella. *U. S. Dept. of Agri., Bur. of Plant Industry, Bull. No.* 252, 1913, p. 95.

As it soon became evident that the fungus infects the fruit even when green, and that, consequently, spraying the fruits long after they had set was useless, and as the disease is most prevalent during the rains, the spraying was done as soon as the "fingers" opened in June, before the rains set in.

On account of the difficulty of procuring pure unslaked lime during the rains, the well-known fungicide, Bordeaux mixture, was not tried, since the application of a badly prepared mixture does more damage to the plant than not applying it at all. In place of Bordeaux mixture, Burgundy mixture (in which lime is replaced by washing soda) was used. Another fungicide that was tried was Ammoniacal copper carbonate. Though this latter checked the disease, still its continued application was found injurious to the fruits. They were sprayed once every fortnight and after the fourth application the spray marks became very prominent. The spray remained lodged where the "fingers" rubbed against each other and here the peel took a sooty brown colour. In cross sections the epidermis and a few layers of the cell underneath it were found to have turned brown, the pulp remaining unaffected. The fruits ripened normally and did not get diseased; but fruits having these spray marks would be unfit for the market. A solution of half the strength used in the previous case failed to check the disease though it did not injure the fruits. As the other fungicide, Burgundy mixture, gave successful results no further experiments were made with different strengths of Ammoniacal copper carbonate. Fruit bunches which had just opened all their "hands" or had partly opened them before the rains set in were selected for spraying. This was done once every month till the fruits were ready for picking, except in the case of bunches which were partly opened at the time of the first spraying when the second spraying was done after a fortnight by which time the "hands" were fully opened. In all at the most four applications were given before the fruit bunches were picked. As Burgundy mixture leaves bluish specks on recently sprayed fruits, they would be unpresentable in the Indian market in this state; so when the last spraying was to be done within a fortnight of the picking of the fruits this mixture was replaced by Ammoniacal copper carbonate which keeps the fruits clean. When the fruits were picked they were dipped in Ammoniacal copper carbonate in order to remove completely the Burgundy mixture marks; these marks may also be removed by gently rubbing them with a brush or cloth soaked in Ammoniacal copper carbonate.

Spraying on these lines has been done for the last three years during the rainy season on a very restricted scale but still the results obtained have been very definite and hopeful. The sprayed fruits developed very little *Glœosporium,* and even this little attack was generally found when the fruit had become over-ripe. As a rule the attack was observed to begin from the distal end of the fruit, from the dried remains of the style. Unsprayed fruits kept as controls got diseased, the whole bunch being destroyed, while over-ripe fruits of sprayed bunches showed only a few *Glœosporium* pustules.

It may be here noted that neither Burgundy mixture nor Ammoniacal copper carbonate have been found to check the scab disease of the fruit.

Along with spraying other precautions are necessary for checking the *Glœosporium* disease. When all the "hands" have opened, the fruit stalk should be cut as far back as the last hand, in order not to have any dead part of the fruit stalk where the fungus may live saprophytically. Fruits when picked must be handled very carefully in order not to injure the peel and thereby not to open *a way for the fungus to enter by. Mummied fruit and fruit stalks must be removed and disposed of at a distance from the plantation or preferably burnt.* The room where fruits are stored should be occasionally disinfected or whitewashed.

Acknowledgments are due to Babu P. C. Kar, Fieldman to the Imperial Mycologist, for doing the spraying work during the writer's absence from Pusa last monsoon.

APPENDIX.

PREPARATION OF BURGUNDY MIXTURE.

This mixture is made in the following proportions:—

2 lb. copper sulphate.
2½ ,, of washing soda (carbonate of soda).
10 gallons of water.

Dissolve 2 lb. of copper sulphate in 5 gallons of water. In order to do this suspend the crystals in a piece of gunny bag near the top of the water in a barrel. It will dissolve in a few hours, but if the crystals have been previously ground they will dissolve more quickly.

Dissolve 2½ lb. of washing soda in 5 gallons of water in a separate vessel. Then pour the washing soda solution slowly into copper sulphate solution in the barrel stirring continuously. The mixture should then be ready for use; before using this mixture it should be ascertained that it is not acid in reaction. If blue litmus paper turns red on dipping it in the solution, add to the mixture in small quantity more washing soda dissolved in water till a fresh piece of paper dipped in the mixture remains blue.

The solutions of copper sulphate and washing soda kept in separate vessels will keep good for several days but once the solutions are mixed, the mixture should be immediately applied, as it deteriorates very rapidly.

Vessels coming in contact with copper sulphate should not be of metal.

PREPARATION OF AMMONIACAL COPPER CARBONATE.

This solution is made in the following proportions :—

Copper carbonate	5 oz.
Strong Ammonia water (B. P.)	3 pints.
Water	50 gallons.

Make the copper carbonate into a paste with a little more than one pint of water. Then add the ammonia slowly and stir till all dissolves, except about ¼ oz. or so. If all dissolves add more copper carbonate so as to have an excess. This gives a deep blue clear solution. This can be kept as a stock solution in a well-stoppered bottle. Dilute this stock solution to 50 gallons with water before use.

A NOTE ON THE INHERITANCE OF CERTAIN STEM CHARACTERS IN *SORGHUM.*

BY

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THE information recorded in this note has been gathered in the course of a study, which is still proceeding, of the varieties of *sorghum* cultivated on the black soil lands of Bellary and Kurnool districts, made with a view to producing heavier yielding types of these varieties.

In 1910-11, from which year the writer's connection with this work dates, it was noticed during an examination made at flowering time, of some strains of selected *sorghums* grown at Hagari Agricultural Station, that in each strain the plants could be relegated to one or other of two distinct groups according to the appearance of the mid-rib of the leaf. In one group could be placed all plants in which the mid-rib appeared as an opaque white band running the whole length of the leaf (Plate III, fig. 2). The other group included all plants in which the mid-rib in the lower leaves was marked by a dull white, generally broken band, never extending across the full width of the mid-rib and rarely to the end of the leaf (Plate III, fig. 3) but in the upper leaves was devoid of any white marking whatever. (Plate III, fig. 1.)

Reference has been made to these two types of plants in a Bulletin[1] on the Madras *sorghums* by Benson and Subba Rao in which it is stated that a greyish mid-rib is held to indicate that the stem will be rich in sugar but that a white mid-rib shows that the

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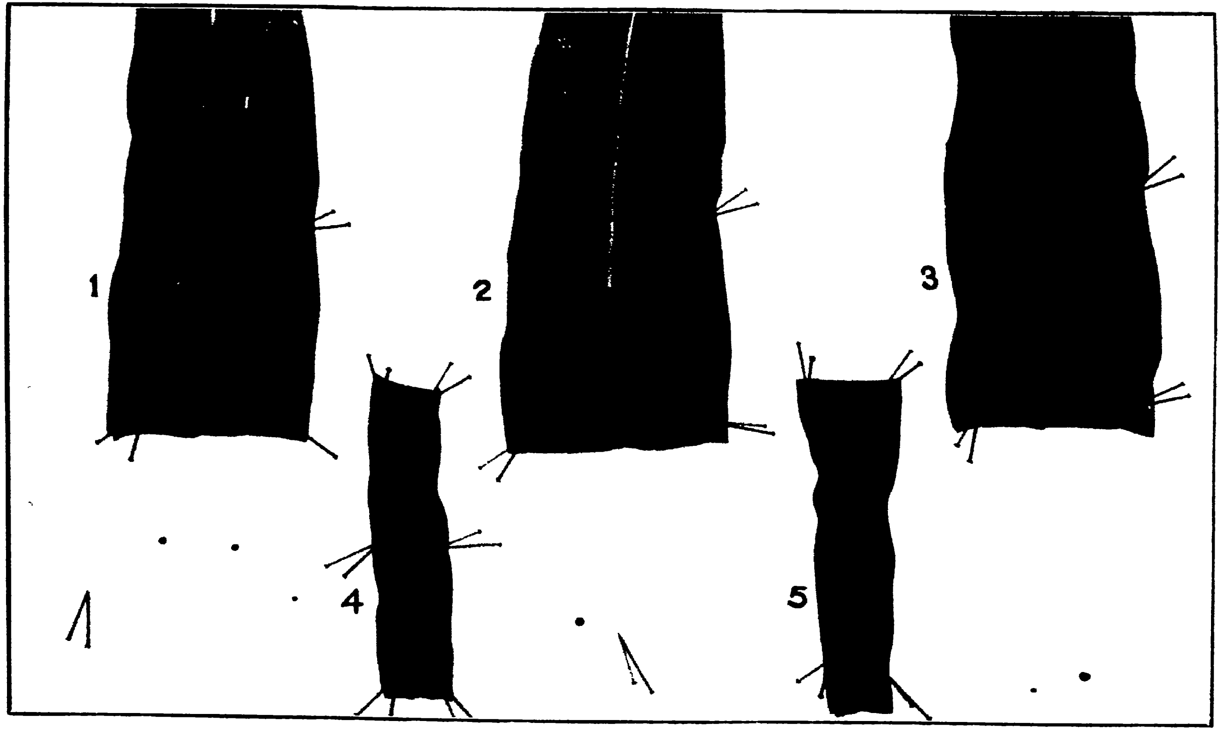
[1] Benson and Subba Rao. The Great Millet or Sorghum in Madras. *Bull. Dept. Agri., Madras.*



1. Upper leaf of sweet-stalked plant showing mid-rib without white marking. Plant in shot-blade.
2. Leaf of pithy-stalked plant showing opaque white appearance of the mid-rib. Plant in shot-blade.
3. Lower leaf of sweet-stalked plant showing dull white marking in the mid-rib. Plant in shot-blade.
4. Lower leaf of young pithy stalked plant, showing the marking as a clear white line in the median line of the mid-rib. Height of plant about 18 inches.
5. Lower leaf of young sweet stalked plant, showing dull white marking in the mid-rib. Height of plant 18 inches.

stem will be insipid. A practical test carried out with the plants of the above-mentioned strains proved the correctness of this belief. Whenever the plant examined could be referred to the first group the stem was dry, pithy and practically tasteless, and whenever it belonged to the second group the stem was very sweet and succulent. The test was made by peeling off the outer rind of the stem and chewing the heart. In the following season a further test was made both on the station and outside in the district with exactly similar results. Inquiry among the local cultivators also showed that they were well aware of the relation between the appearance of the mid-rib and the character of the stem and were in the habit of making a practical use of their knowledge when they wanted a little light refreshment in the field but not when they were selecting seed for the next year's crop. Since that time the writer has, while touring in different parts of the Presidency, taken the opportunity whenever possible of testing this relationship and has never been able to record an exception.

In 1913-14 a number of naturally fertilized single plant selections, the character of the stem of which had been recorded at the time of selection, were sown in separate plots at Hagari and Nandyal agricultural stations. When these came to be examined it was found that with two exceptions the progeny of the sweet-stalked parents were all sweet-stalked. The exceptions contained three and four pithy-stalked plants respectively. In one case, a possible, but not probable explanation for the appearance of these pithy-stalked plants was that seed had been transferred from a neighbouring plot by ants, in the other case this explanation was not possible and their occurrence could be due only to cross-fertilization. Similarly, the progeny of the pithy-stalked parents were with two exceptions all pithy-stalked, but in these two the admixture of the foreign type was so great and the position of the plots was such that cross-fertilization afforded the only possible explanation for its presence. Counts were made in these two plots and the following numbers were obtained:—

	Pithy-stalked	Sweet-stalked
At Nandyal	448	153
At Hagari	207	76

These numbers are a close approximation to a three to one ratio and in order to obtain further information a number of plants were selected and the heads were bagged to prevent cross-fertilization. The selection was made as follows:—

(1) Plants of both types from the two impure pithy-stalked strains.

(2) All the pithy-stalked plants found among the progeny of the sweet-stalked parents, and some of the sweet-stalked plants from the same parents.

(3) Sweet-stalked plants and pithy-stalked plants from the plots in which the plants were all of one type.

(4) Also at Hagari a number of plants of both types were selected in some plots of older selections in which both types were found to be present. In this case some of the heads were not bagged.

All of these selections were sown in separate plots in 1914-15 and were examined from time to time during the course of their growth. In the case of the self-fertilized plants it was found that in every case the sweet-stalked parents gave nothing but sweet-stalked progeny, but that while some of the pithy-stalked parents gave nothing but pithy-stalked progeny, others gave plants of both types. Counts were again made in these impure lots and the following numbers were recorded:—

		Pithy-stalked	Sweet-stalked
At Nandyal	1.	190	52
	2.	193	68
	3.	115	41
	4.	157	58
	5.	221	87
	6.	192	74
	7.	183	68
		1,251	448
Ratio approximately		3	1

The season was unfavourable at this station and the plots were thinner than they ought to have been.

Plant No. 1 was one of the three pithy-stalked plants found among the progeny of a sweet-stalked parent. The other two heads failed to set seed.

Plants Nos. 2, 3 and 4 were similarly from the four pithy-stalked plants found among the progeny of a sweet-stalked parent. The fourth head failed to set seed.

Plants 5, 6 and 7 were pithy-stalked, selected from the impure pithy-stalked strain.

		Pithy-stalked	Sweet-stalked
At Hagari	1.	53	14
	2.	39	23
	3.	52	16
	4.	50	23
	5.	36	16
	6.	33	13
	7.	55	9
	8.	46	15
	9.	34	19
	10.	65	26
	11.	56	18
	12.	49	29
	13.	38	21
	14.	76	3
	15.	41	33
		723	278
Ratio approximately		3	1

At this station the season was distinctly adverse, hence the smallness of the numbers and the irregularity in the proportion of plants of each type present in the different plots.

Plants 1, 2 and 3 were pithy-stalked plants selected from the impure pithy-stalked strain. The other plants were the pithy-stalked types selected from the plots of older selections found to be impure.

In the case of the naturally fertilized plants, as was to be expected, both types gave progeny either all of the same type as the parent plant or with some admixture of the foreign type. Out of fifteen naturally fertilized sweet-stalked parents eight gave progeny which contained a few pithy-stalked plants. No counts were made in this series.

Some of the pure strains it was considered worth while to test further for yielding quality and selfed seed was collected from each of them. The plots are again pure this year, containing nothing but sweet-stalked or pithy-stalked plants according to the character of the parent stock.

When making counts in the impure lots it was found that unless the plant had reached the shot-blade stage it was not always possible to refer the plants definitely to one class or the other, but at that stage it was always possible to do so. This difficulty was felt most acutely at Hagari in 1914-15 season when the growth of the plants was poor. The figures quoted for that year and station show the actual numbers of plants which had reached the shot-blade stage at the time of counting, as all other plants were ignored. Examination of the plants of pure strains has therefore been made during the last two years, and the development of the white-marking of the mid-rib has been watched and the following information obtained:—

When the plants are small, that is up to the time when they are about six or seven inches high, no white marking is present in the mid-rib of the leaf and both the sweet- and pithy-stalked plants look alike. Later, the white-marking begins to develop in the lower leaves of both types. In the pithy-stalked types it shows as a distinct white *line* running along the median line of the mid-rib and extending practically to the end of the leaf. (Plate III, fig. 4.) In the sweet-stalked types, the line is dull not so plainly marked, is as a rule broken and does not generally extend further than a little more than half the length of the leaf. (Plate III, fig. 5.) As the plants grow the white-marking develops, much more quickly however in the case of the pithy-stalked plants, until when the plants are in shot-blade, *all* the leaves in the case of the pithy-stalked plants will have white mid-ribs, the white-marking having by that time extended right across the whole width of the mid-rib. In the case of the sweet-stalked plants only the lower leaves will show white-marking which will be in the condition described at the beginning of this paper. Later still, when the grain is beginning to ripen, an increase in the amount of white-marking will be noticed in the case of the sweet-stalked plants. In most cases the lower leaves will resemble those of the pithy-stalked plants, but a difference is always discernible provided that the leaf has not dried up. The white is not so white and does not occupy the whole width of the mid-rib. The uppermost leaf by this time will also have begun to show some white. No change is discernible in the appearance of the mid-rib of the pithystalked plants after they have reached the shot-blade stage.

To summarize, the results obtained show that—

(1) the character of the green stem in *sorghum, i.e.*, whether it is pithy or sweet, can be readily diagnosed from the appearance of the mid-rib of the leaf when the plant is in shot-blade and for some time after;

(2) in breeding tests the pithy character behaves as a simple dominant to the sweet-stalked character.

INDIGENOUS IRRIGATION WORKS IN BIHAR AND THEIR IMPROVEMENT.

BY

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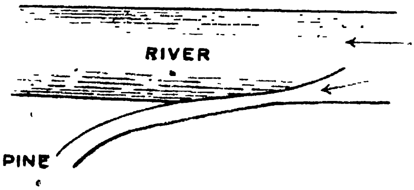
INDIGENOUS irrigation works occur to some extent throughout most of Bihar, but they are found at their best and in greatest number in the Gaya District and in the south of the Patna District, and in this article only these districts will be described.

South Bihar, like other parts of the Province, is liable to suffer from scarcity in years of deficient rainfall, but where this interesting system of irrigation works exists, it constitutes an assurance against serious famine, except in years when the failure of the rains is very bad indeed. And this, notwithstanding the fact that over 52 per cent. of the cultivated area is under rice, and the average rainfall at Patna and Gaya is 44 and 42 inches, respectively. In fact Gaya, where irrigation works are found throughout the district, is practically safe from famine, for though it suffered to some extent during the scarcity of 1866, in that of 1874 it only received a small measure of relief, given more as a precautionary measure than as a necessity, while in the famine of 1897 no relief was required. In the district of Muzafferpur in North Bihar, on the other hand, where the soil is very retentive of moisture, but irrigation facilities do not exist, the suffering was much greater in each of these famines, and necessitated considerable outlay on relief.

The two districts, Patna and Gaya, are adjacent, Gaya being immediately south of Patna. They are bounded on the north by the Ganges, which separates them from North Bihar, on the west by the Sone river, on the east by the Bhagalpur Division, and on the south by the mountainous Chota Nagpore Division. The physical aspects of the tract must be studied in order to understand the system of irrigation works. First, in the north a narrow, but varying strip of low land is met with, known as the *diara*, running right across from east to west along the edge of the Ganges. This is usually flooded in the rains, but grows excellent crops at other times. South of this there is a bank of high land, which also runs from east to west roughly parallel to the river. It is along this high land that the East Indian Railway main line has been constructed. Continuing south the land falls sharply into a depression, which slopes from west to east, and is of greatest area in the Barh or north-eastern subdivision. This belt of very low-lying land varies in depth from three or four to about fifteen miles. Once across this the land begins to rise as one proceeds south, at first very slowly, then more rapidly. In the Northern or Patna District the rise, though steady, is almost imperceptible, the general appearance being a vast alluvial plain, broken by villages, mango groves, and lines of palm trees, with hills perhaps visible to the south. After crossing into the Gaya District the same appearance is presented by the Jahanabad subdivision, except that now solitary hills can be seen dotted about to the south. On leaving the Jahanabad or Bihar subdivision the plain begins to rise more rapidly, small isolated conical hills, covered with jungle scrub except where there is bare steep rock, break through its surface here and there, and a line of low hills runs north-east starting near Gaya town. Gradually the land climbs up, until, near the southern boundary, it meets, and is cut into by, the spurs of the Chota Nagpore hills, the lower ranges of which stretch right along the southern end of the district, wild, rocky, and covered with forest, jungle, or scrub.

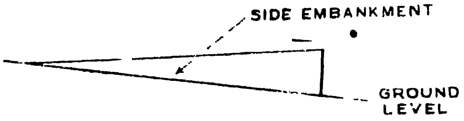
Across this sloping plain, from south to north, run numerous parallel streams which rise in the southern hills. Flowing at first nearly due north they afterwards bend to the north-east, and then to the east. This easterly course is taken when they have reached the low depression lying south of the Ganges, and the land of that area is subject to more or less serious floods nearly every rains when the rivers overtop their banks and spread across country, almost at will. Only one river, the Poonpoon, succeeds in forcing its way through the high bank bordering the Ganges, the others turn to the east, flooding out into marsh or *jhil*, until they eventually find their way into the Ganges lower down and outside this division. In the hot weather, and even earlier, in the cold weather in some cases, the river beds are nearly all mere dried up sandy tracks, but in the rains they fill rapidly and carry down a considerable volume of water.

It is over this plain, which slopes from south-west to north-east, and is cut up by numerous rivers, that a network of private irrigation works has been constructed. The area is characterized by a scanty rainfall and a rapid slope, four to six feet per mile in the southern Gaya District, off which the water quickly runs, while the soil, which is usually either stiff clay or loose sand, is not very retentive of moisture. Rice can only be grown, therefore, by impounding and using every drop of water that can be got. This is done in two ways, first by long, narrow canals called *pines* which open out of the rivers and lead the water from them to the fields on either side; and secondly, by catchment basins (called *ahars*) which hold up and impound the water behind embankments built across the line of drainage.



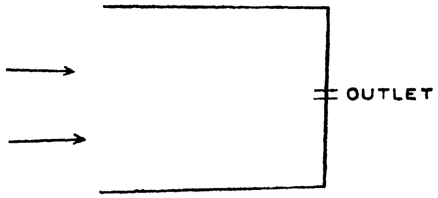
Diagrammatic plan of river and pine.

The *pines* lead off from the rivers at an angle in such a way that the water flows down them to fields at a lower level. Thus if a river is flowing north, the *pines* will stretch out north-east and north-west from it, like twigs from a stem. The mouth of the *pine* faces up stream and a bund runs out into the river bed to turn the water into the canal. These bunds are frequently of masonry, and may be continued across the river's bed as the volume of water decreases. The lengths of the *pines* vary considerably. Some of them are merely rough ditches stretching for a mile or so, many of them are five to ten or even twenty miles long with numerous branches (*bokla*). One, near the Patna-Gaya boundary, is said to be 80 miles long, including all its branches ; and it would appear that their number and length is much greater than is suspected, even by those who know the country well. As they vary in size and length, so do they in general appearance. Some are fed by rough irregular bunds scratched up in the river bed, others have well made embankments for this purpose, which are often built of masonry. Some contain pukka sluice gates, and many branches, with brickwork openings to let the water into the fields. Frequently they travel for considerable distances embanked above the level of the surrounding country, gradually sinking until they are below the level of the fields on either side. In short, they are adapted in numerous ways to the various needs for which they are built, and the natural characters of the country which they serve. One large *pine* near Gaya, for example, flows for two miles into a depression used as a lake, the water in which is increased by the drainage of a considerable area, and the rain water that washes down from a hill that borders it on one side. The lake is partly enclosed by an embankment across its lower end, in which are large masonry sluice gates, opening into another *pine* that takes the water for a further twelve or thirteen miles. When a *pine* or *bokla* is above the level of the land the water is run into the rice fields by small distributary channels, but when it is too low to flow out in this way it is raised by lifts. The *pines* may discharge their surplus water into another river bed, or into a *jhil ;* but in the majority of cases they either run into an *ahar*, or simply end in small channels, so that all the water is used upon the fields.



Diagrammatic plan and side view of an *ahar*.

Between the rivers from which the pines lead off the land rises from either side to the watershed, and it is on this higher land that *ahars*, the second form of local irrigation works, are chiefly found. They also exist, however, interspersed among the *pines* themselves. An *ahar* is a catchment basin, usually more or less rectangular in shape, formed by building an embankment across the drainage line, with two sides running up the slope, that is, in this district, where the land slopes nearly always to the north, a bund is built from east to west, and from its ends two other bunds are taken south, which gradually decrease in size as the level of the ground rises. Some of them are built to catch the surface water only, others are built across a drainage rivulet. In all cases there is an outlet at the lowest point, where the water would ordinarily flow if no embankment had been made. If the water flows in from a rivulet or *pine* there is usually a weir in the northern bank; this may be topped by a *tar*-tree stem, but is frequently made of masonry. The water flowing out of one *ahar* often passes on only shortly to be caught in others.



As in the case of *pines*, *ahars* vary considerably in size and general appearance. Some are very large indeed, with masonry weirs and numerous sluice gates to let out the water for irrigation; others discharge their water through pipes made of hollowed *tar*-trees, in others again, and these are mostly small, the bank is simply cut.

The people are fully conscious of the advantages of these irrigation works, and have evolved a system which should tend to keep them in repair, and to increase the number built. It is obvious that the *raiyats* could not, and would not, construct such works, nor could they keep them in repair when they exist, as they have not got the necessary capital, nor are they likely to combine in sufficient numbers. It is necessary, therefore, that the zamindars, or landlords, should take the matter up. The general opinion evidently was that in order to make them do this, the prospect of an increased rent would not be sufficient, and it was so arranged that the amount of rent depended entirely upon the extent to which facilities for irrigation were provided. This is done by letting out the irrigated lands for the most part, on produce rent (*bhaoli*) whereby the landlord receives a little more than half the crop. The crop is appraised in the field before it is reaped, and the value of the landlord's share is paid by the tenant, either in cash or in grain. The *bhaoli* system is found scattered here and there in all parts of Bihar, but as the *raiyats* much prefer to pay fixed cash rents (*nagdi*), produce rents occur as a rule only when there is some special reason, as in this case, for the system gives the landlord excessive power over his tenants. We find, therefore, that about 70 to 75 per cent. of the rents in Gaya, and about ⅔rds of the rents in the Bihar subdivision of Patna are paid on the *bhaoli* system. In the Saran District, on the other hand, where there is little irrigation the proportion is only about 5 per cent. Construction works and big repairs are undertaken by the landlords with men hired for the purpose; but small annual repairs and petty works, such as clearing silt from *pines*, closing small breaches, and repairing the lesser distributary channels, are carried out by the tenants on the *goam* plan, that is, one adult of every family benefited by the particular irrigation work concerned is called out to do the work, for which he usually receives no remuneration either in cash or kind.

An elaborate set of rules for the distribution of water has been drawn up in the course of time by custom and mutual agreement. These settle where, and for how long, bunds may be built to turn the water; which distributaries may be opened first when more than one are wanted, and the time they may be used; the length of time each village, or each block in a village, may receive the supply, and other similar questions.

From the details given above a picture of an ideal irrigated tract can easily be imagined. The landlords, singly and in combination, build *pines* and *ahars* in every useful spot, keeping them in thorough working order. By their power and prestige they aid public opinion in enforcing the laws governing the supply *in turn. The tenants* willingly carry out the work of repairs for wages when *the work is large, but without when it is small.* Cultivation is careful and intensive, and the outturns large, thus *benefiting both raiyat and zamindar.*

The reality, unfortunately, is not like this. Practice falls short of theory for many reasons, some of which have more effect in one place, others in the next. First among them is the gradual division of property, the parcelment of large holdings that has been encouraged by a settled rule. Where formerly there was but a single zamindar, there are now perhaps fifty petty landlords, whose interests conflict, or whose relations are so strained that they will not combine. The result is that no new works of any size are undertaken, these works having been carried out as a rule in the past by one man who owned the whole area to be irrigated. More than this, such large works as do exist are falling rapidly into disrepair, owing both to lack of means on the part of the numerous smaller men who own them now, and to their mutual jealousies. A case of this is very evident near Warisaliganj in Gaya. Here some twelve or more years ago the Sakri river turned into the channel of one of its *pines*, with the result that the supply of water for the canals further down has gradually been cut off, while the original *pine* has been enlarged into a river bed blotting out a large culturable area. Various landlords are concerned, many of whom are willing to combine, but, as others still refuse, nothing is done, owing to a natural disinclination on the part of those willing to do their share to incur expense for the benefit of those who will not join. Again, the Holya *pine* which passes through the village of Chandragarh in the west of Gaya, could irrigate much more land than it now supplies, but the zamindars of Chandragarh will not allow the water to be used by others because their ancestors incurred the expense of building the canal. The surplus water, therefore, runs to waste. Examples more or less like these are common. All this results in full use not being made of the present *pines*, and no increase of the irrigated area.

A second cause is lack of engineering knowledge and experience. On the whole, the engineering ability displayed is large, but if the works were under expert care very much more could certainly be made of them. The unfortunate mishap at Warisaliganj described above is not unknown elsewhere, but such would not occur if an engineer were to direct the work.

Thirdly, the tenants themselves do not make the best of their opportunities. The fact that more than half the produce goes in rent leads to slovenly cultivation. Nearly every raiyat has some *nagdi* land besides that which he holds on *bhaoli*, and all his spare time and extra care are spent on cultivating the former, the latter getting much less thorough work.

Fourthly, disputes about precedence in receiving water are frequent, both among people served by the same *pine* and between villagers of areas lower down with those above them who may have dammed a river to turn the scanty flow. Riots constantly occur in years of deficient rainfall, and especially when the *hathia* rains fail. So numerous are these disputes and riots that more than five per cent. of the time of the District Judge is taken up by irrigation cases.

Nevertheless, in spite of its shortcomings, there is no doubt that the indigenous system of irrigation described above is indispensable. The exact amount of benefit derived from it is difficult to gauge but it is very great, and without it certain parts of the country would be an uncultivated waste. Its usefulness of necessity varies from year to year with the varying rainfall. The manager of a large estate estimated that over a number of years the rice on the irrigated tract is double that on the other land, and in bad years the rice on the unirrigated area is *nil*. Even this is no exact description of its value, for in many cases irrigation facilities have been provided for those lands on an estate most in need of them, the unirrigated fields being those that can most easily do without.

Allowing then that the scheme is a good one, and that it adds largely to the general prosperity of the people, and saves the area from famine, the question how to improve and extend upon it is one of the greatest importance. The question is not a simple one, as a little consideration will show, nevertheless it should be faced, and in the writer's opinion it is one about which the Provincial Agricultural Department should interest itself peculiarly. This view is not universally accepted, for it is sometimes objected that the matter is too big and any way one that concerns legislators only. But nothing should be too big for the Agricultural Department or outside its province that is connected with agriculture and the welfare of the agricultural classes.

The improvement of existing conditions has already occupied the attention of the authorities, and a Bill was under discussion in Bengal but was dropped when Bihar and Orissa was formed as the subject concerned that province. The chief points of the Bill as proposed may be summarized as follows :—(1) The Collector can direct and compel fulfilment of a record of rights in respect of the use of water and repair of the means for securing a supply of water. (2) The Collector may, if he thinks fit, direct the construction of any sluice, weir, or other work necessary to regulate the supply of water in accordance with any rights recorded in a record of rights. (3) Any person desiring the construction of a new irrigation work may apply to the Collector if he cannot acquire from its owners the land needed; and the Collector, if he thinks the new irrigation work expedient, and if any objections on the part of any other people do not appear to him valid, can enforce the transfer of the land necessary, and settle the amount to be paid for the land. (4) In the same way if any one desires the transfer of any irrigation work from its present owner to himself, the Collector, if he thinks the said transfer is necessary for the better management of the irrigation from such irrigation work, can enforce the transfer and settle the compensation due. (5) Where in any area the rent is on the *bhaoli* system, or has been fixed or enhanced in consideration of irrigation facilities, or irrigated for 20 years, or irrigation works have been carried out under sections 4 and 5 above, and the irrigation works are out of repair, the Collector can cause them to be repaired. (6) No person can make a dam across any irrigation work unless he has the right to do so, and if he does, the Collector may remove it.

In discussing the Bill as here proposed the writer does so as an agriculturist, and without the least pretence to what, perhaps, may be called the legal knowledge necessary, and his definition of legal knowledge would probably include many matters a lawyer would not include. This must be plainly understood both in respect to the criticisms and suggestions. It is quite possible that the latter may be impracticable for reasons outside the writer's view, and for that reason they are put forward very tentatively.

Provided that the subject is approached on the lines of the Bill little more can be done than has been done, and sections 1, 2 and 5 above will result in a great improvement in existing works. That such an improvement is necessary is shown by reports which were called for from all the areas concerned, and which gave numerous instances of works that had fallen into disrepair. The most common cause given for this neglect in repairing the works was the difficulty of co-operation that arises in estates held by numerous co-sharers, and among several zamindars. Another cause given was poverty. And another, though not so common as the above, a desire to oppress the tenants, particularly in cases where the *raiyats* wish their rents to be fixed payments in cash. If, however, we turn to the ways in which the actual falls short of the ideal given above, it is at once apparent that the Bill does not remove several of the disadvantages there set forth. It does not provide adequate means for the increase of the area under irrigation, it does not help the abolition of the *bhaoli* system, and it gives only a partial insurance against engineering mistakes.

With regard to the necessity of providing for an increase of the area irrigated. In a few tracts the irrigation works are complete, but in large areas they are not. It is impossible to estimate accurately the extent of land which might be, but at present is not, irrigated; to do so would require a survey by an engineer and an agriculturist. There is no doubt, however, that this area is large. The eastern portion of the Aurangabad subdivision is said to be capable of considerable improvement in this respect. In the Jehanabad subdivision, and the south of the Patna District a lot of water runs to waste; and it has been estimated that three-quarters of the former tract could be irrigated if proper works were erected. To give two specific examples, the District Board Engineer has reported that in one group of villages in the west of Gaya whose area is 14,168 bighas, 3,472 bighas are irrigated by *pines* and *ahars*, the remaining 10,696 bighas could be irrigated if the existing *pine* were repaired and enlarged. He has also reported that in Kutumba perganah out of 121,018 bighas, of which 18,692 are irrigated, a further 41,817 bighas could be irrigated if the *pines* were put in order and enlarged. These last two examples are not exceptional. They apply, of course, only in part to the construction of new works, and include repairs such as the Bill will introduce. Section 3 of the Bill does not meet this difficulty of increasing the area sufficiently, the method of procedure in applying to the Collector may deter some would-be applicants, and at best it only provides facilities for men able to pay for the erection of the works.

With regard to the advisability of abolishing the *bhaoli* system of rent. This system, in the majority of cases, is bad, and it only exists to the large extent found in this part of the Province because of the irrigation works. A former Collector of Gaya has reported "The system is advantageous to a powerful and unscrupulous landlord, as against a poor and weak tenantry and keeps up, or fosters the existence of, so many middle men and encourages so much dispute, peculation, and dishonesty on all sides as to stamp it unmistakably as bad.... It is the fact that it favoured the rich and powerful that has caused it to maintain its position so long." Under the *nagdi* system the tenant puts better work into his land, and is almost invariably more prosperous. While the matter is under consideration it would be a very good thing if the abolition or reduction of the *bhaoli* system were kept in view.

If the whole matter could be approached from another angle, might it not be possible to avoid the three objections given above? The erection of efficient irrigation works is very profitable; they have on occasions even paid for themselves by the extra rent in the first year. Now would it not be possible for Government to take over the repair and extension of the works itself, making the users pay? A tax might be levied on both landlord and tenant, and the proceeds used for carrying out repairs, either under engineers on a par with the District Board Engineer, or preferably under the Public Works Irrigation branch. The same organization that kept up the existing works might be used to look out for places where new works are required, in conjunction to some extent with the Agricultural Department. New works could be erected on borrowed capital, the rates levied being used to pay back the capital with interest in a certain number of years.

Further, co-ordinated superintendence by a qualified engineer would result in an approximation to the ideal that no available water should be wasted. It is not suggested that such supervision could provide sufficient water for a maximum crop in scanty years, but it would prevent the loss that at present occurs. Another point also these experts might consider is the suggestion that artesian wells can be bored in Gaya.

Some such system as this would get over the difficulty of the extension of these works and the lack of engineering knowledge, while it would certainly cause a gradual change in rents from *bhaoli* to *nagdi*. There are, of course, difficulties which are at once apparent, but most of them are 'legal' difficulties, which in this article are taboo.

CATTLE BREEDING, WITH SPECIAL REFERENCE TO THE MILCH COW.*

BY

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AT the last year's Conference of the Co-operative Credit Societies held at Benares I had the pleasure of reading a paper dealing with that most important subject, *viz.*, the improvement of the Indian cattle. I then described the disadvantages which we suffered in this country, and the difficulties which we had to surmount. It was pointed out that the question of grazing lands had first to be dealt with, and I think I mentioned that where insufficient pastures existed, it would be necessary to take some steps to provide for the deficiency in grazing by giving more attention to the economics of feeding by other methods, and by the use of such foodstuffs as could be cultivated, purchased, or otherwise procured. Steps have already been taken in this direction. The reclamation of ravine lands for grass has been undertaken and at the same time the question of the opening of forest areas for grazing is being given due consideration. In those tracts where grazing is very limited small holders are being encouraged to reserve a small portion of their land for the growing of fodder crops, and the use of many valuable foodstuffs, such as cotton cake, is being widely introduced. So much then for the question of feeding.

We next discussed the necessity for an adequate supply of breeding bulls. To meet this demand two Government farms have now been established and are commencing to issue on loan bulls of the best varieties which are considered suitable for the various tracts of the province. The Hissar, Kosi, and Sahniwal (Montgomery) strains are being maintained for the western districts and for those herds where milk production is the primary object. For those tracts in Oudh where small but sturdy plough cattle are required the Kherigarh, Parehar, and Ponwar breeds are recommended and are being issued.

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* A paper read at the Provincial Co-operative Conference held at Lucknow in February 1916.

Buffaloes of good milk yielding strains are now bred; and bulls of this description will also be distributed. Government has sanctioned the giving of advances for the purchase of good cows in those parts where an improved type seems desirable, and suggestions have been circulated for the proper care and management of breeding stock, and the rearing of young calves. In order to encourage intelligent selection in regard to the mating of the cattle, a scheme is being drawn up for the local award of prizes for the best specimens of calves bred by the owners of cows, and got by the Government bulls. Due notice will be given of the dates from which these awards will commence in order to allow intending breeders sufficient time for the selection of cows for breeding of the young stock.

So far then as much as can be accomplished for the present has been done, but even the improvement of grazing grounds, the distribution of bulls and improvements in other directions which I have mentioned, will not be sufficient to produce any very marked advance until more personal and intelligent interest in the matter of breeding and general management is shown by the breeders themselves. I regret to say that except in a very few cases insufficient attention is paid to the fundamental principles of breeding. The breeder's aim is often only to obtain a calf, and for this purpose he will have his cow covered by the nearest bull without bothering as to what it is likely to turn out and without regard to the quality of the sire, or the suitability of the union. Cows are frequently allowed to mate with undersized, immature, ill-shapen mongrels, and still more often with old and decrepit animals. In many cases cows of an essentially small breed are provided with an unnecessarily large and unsuitable bull, the product generally being an awkward, unwieldy bullock, totally unsuitable for the tract it is to work in. On the other hand, good milk cows of large size are frequently allowed to be covered by small indifferent bulls of a poor milk giving variety.

The inferiority and unsuitability of many of the bulls in this province may be responsible in a great measure for many barren cows; nevertheless, it is the want of attention and care at the time of mating that has been the cause of considerable loss, on account of cows failing to conceive, which otherwise should have produced good calves. The financial aspect of cattle breeding does not receive sufficient attention from the breeder. It may be said of stock rearing as of other matters that time means money, and by breeding regularly from a cow and utilizing the services of a suitable bull, a much greater return for that cow's value will be obtained in the number of calves produced and the amount of milk yielded.

My remarks of course generally apply to all classes of cattle and buffaloes, but I would here like to take the opportunity of saying a few words regarding cattle breeding as it specially affects milk production. It is not proposed to discuss the question from an entirely commercial aspect nor from the point of view of the *gowala.* I shall confine myself to the subject more as it affects the private owner who wishes to keep good cows for milk for his family or those persons who are interested in breeding improved dairy cattle. As you all probably know, the sole object of the professional *gowala* is to obtain milk. He is not usually particular as to its quality or cleanliness, provided he can obtain a sufficient quantity daily to keep his trade going and bring him a more or less regular living. This usually leads to the frequent as well as wasteful practice of milking a cow until she has become dry, and then selling her barren for whatever little she will fetch. I am sorry to say there are many cows wasted yearly in this way which would otherwise have continued to fulfil a useful purpose as breeders and milk producers. The reason of this practice is probably to be found in the want of facilities for maintaining cows between the period of their ceasing to milk and the birth of the new calf. It is thought that dry cows are a trouble and expense to keep, but unless the animal is an inferior one a cow will amply repay her owner if proper arrangements are made to provide for her in the meantime. It is here that co-operation would be most effective by enabling arrangements to be made for cheap grazing, maintenance, and attendance, for dry cows and those in calf. With the private owner, however, no difficulty should arise in this respect, and he will find it to pay better to continue breeding from his cows if they are good than to milk them out and sell them barren. A cow usually may be covered when her calf is four to five months old and this should always be done. As pregnancy advances the milk supply will gradually decrease but this is compensated for by having to maintain the cow when dry only for a short period.

For family purposes or where two or three owners can work together, the following plan has been recommended. To begin with, one cow in full milk should be purchased, and five months later, another one also in full milk. After a further five months a third cow in the same way may be added to the herd. Now, if a cow give 10 seers daily she will, when in full milk, most likely average 7 seers daily for nine months and with proper care she should give a calf about every 14 or 15 months. Therefore, when the first cow is half through her time of milking and the yield is commencing to decrease the second cow will be in full milk and by the time the first one actually stops milking the third is commencing to give its supply. Thus by the time the second one stops, and the third is half through her time and her milk beginning to diminish, the first cow will calf again and will recommence to give her yield. By this method if they are good cows they can all be retained and will pay their way. The financial return of such a system can be easily worked out and after deducting expenses for feed and keep from the value of milk and calves produced it will be found to be a paying transaction. I would here like to impress the fact that inferior cows are under any circumstances a bad investment. It is well known that it costs practically as much to maintain a bad animal as it does a good one. Old cows should never be purchased; it is better to buy an animal giving her second or third calf. Buyers are often deterred by high prices and sacrifice quality to economy. If, for example, a cow gives an average of 7 seers daily the value of its produce at 8 seers to the rupee is 14 annas daily. If the cost of its up-keep be 8 annas the net daily profit is 6 annas or about Rs. 12 per month, being a clear return of Rs. 108 in the nine months. Hence there should be no hesitation in giving a good price for such a cow. If, on the other hand, Rs. 40 be given for a cow giving only 4 seers the money value of her produce does not average 8 annas a day which probably hardly covers her feed and keep, so that the profit is *nil* and the animal does not win back her price. Furthermore, if judiciously mated, the calf of the superior animal will be worth far more than that of the inferior cow. A cow well purchased is so much capital if properly managed, and a calf is an increase on that capital, and the cost of feed and keep should be more than balanced by the milk and ghee which she supplies.

If it is milk that is required, care should be taken in the selection of cows and only those of milking breeds should be purchased. A cow, may be a large, good looking, shapely animal yet may be practically worthless for the dairy. The best milking cows for Upper India are those of the Hissar, Hansi, and the Montgomery (Sahniwal) breeds. The former if fed properly generally do well in most parts of the United Provinces, although perhaps they will not give quite such a heavy yield as they do in their native climate. The Montgomery strain are smaller cows and very excellent milkers, although in some of the eastern tracts of the Province they are said to lose their milk-giving powers to some extent. The Kosi or Mewati strain which are usually bred in the tract of country known as Mewat are fair milkers but usually not so productive as the Hissar variety. Experiments have recently been carried out on some of the Government farms with a view of ascertaining if permanent improvement in the milk producing capacity of the Indian cow can be achieved by crossing with some of the noted British dairying breeds. Originally some prejudice existed in regard to this, as it was predicted that the progeny of such a cross having no inherited immunity would rapidly fall victims to the many animal epidemics in the country. Furthermore, it was stated that the bullocks would have little or no hump and for this reason would be useless as working cattle. Thanks to the immunity conferred by protective inoculation the first objection has been found to be surmountable. With regard to the second, experience has shown that the necessity for the well developed hump has been greatly exaggerated and wherever Government military dairy farms are established, it is now no uncommon sight to see half-bred English cattle drawing immense load or carrying out other draught work; nor does their working capacity appear to be in any way inferior to that of the pure country bullock. The Civil Veterinary Department has recently imported bulls of the celebrated Shorthorn and Ayrshire varieties. Many half-bred cows got by bulls of this breed have been known to give as much as 20 seers of milk daily. With regard to buffaloes the indigenous breed of these provinces are comparatively poor milkers. The breed known as Murrah which is found in the Rohtak District of the Punjab is perhaps the best for dairy purposes, and animals of this variety can usually be procured from the Jehazgarh and Amritsar fairs.

Intelligent selection and purchase, liberal feeding, careful management, attention to cleanliness and hygiene as well as regular and systematic supervision are the factors which make for successful cow-keeping, and if greater attention and care were devoted to this industry in India it would have a far-reaching effect not only on the health but the wealth of the community.

RICE, AS PREPARED FOR FOOD IN BENGAL.

BY

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IN those countries where it is only an article of import, rice denotes the husked and more or less polished grain of *Oryza sativa*. In the countries where this crop is grown, unhusked rice is so distinctive an article of commerce and domestic use that the English language has adopted for it the Malay word *padi* more usually written *paddy*, which corresponds to the Bengali word *dhan*. The large number of vernacular words each denoting paddy or rice in some particular condition or stage of preparation can, however, only be translated by the above simple names qualified by adjectives which readily escape the memory of an enquirer into the subject. Even when remembered they do not fully indicate the complex domestic or ceremonial usages associated with the vernacular words. It is thought that the publication of a brief account of these in permanent form may be of interest and of definite use as a first step towards a serious consideration of the varying dietetic values of rice used as a food-stuff in a major province of India. On this latter point, Hooper (*Agricultural Ledger*, 1908-09, Vol. V, p. 67) remarked that it appeared very desirable to undertake an investigation to ascertain something more than is at present known regarding the chemical composition of the various grains and supplied analysis of a given number of samples of rice. He also makes preliminary statements upon the nutritive value of these grains as they pass through different stages from paddy to more edible forms; upon the losses due to polishing and cleaning, with reference to the work of the Louisiana Experimental Station 1904, and on the losses due to cooking. As an example of the last the following figures calculated to a water-free basis are instructive :—

	Rice (*Chal*)	Boiled rice (*Bhat*)	Loss
Albuminoids	7·9	7·2	0·7
Fat	0·3	0·1	0·2
Carbohydrates	90·7	83·5	7·2
Fibre	0·4	0·4	—
Ash	0·7	0·6	0·1
Total ...	100·0	91·8	8·2

Whilst most of the information about rice is of an historical or statistical character, a little of a domestic nature is available. In his Statistical Report of Bengal (1875, *et seq.*), a monumental work of 19 volumes, Sir W. W. Hunter records several hundred vernacular names for different kinds of paddy, then grown in the Province. whilst Sir Geo. Watt (*The Commercial Products of India,* p. 823) states that there are altogether about 20 botanical varieties of paddy, of which five are very distinct. The former writer (*loc. cit.*) has noted under each district a few preparations of rice, those for the Faridpur District (Vol. V, pp. 300-304), based on a report by Dr. B. N. Bose, the Civil Surgeon of the District, being the most detailed. An effort is now made to cover this ground more fully according to the following synopsis and to bring into prominence those points where it is thought that scientific enquiry may be most usefully directed.

Synopsis.

I. KHAI. (paddy roasted, then husked mechanically.)
    (1) *Murki* (sugared Khai).
        Varieties .. (*i*) Gur Murki.
            (*ii*) Sugar Murki.
    (2) *Khai-chur* and *Moa.*

II. CHAL. (paddy husked in various ways.)

(1) *Alo-chal* (mechanically husked paddy-rice).

Preparations .. (*a*) Bhat.
(*b*) Payes.
(*c*) Polaw (pilaw).
(*d*) Sofeda.
(*e*) Ruti.
(*f*) Pithe.
(*g*) Saruchakli.
(*h*) Malpo.

(2) *Siddha-chal* (Paddy, steamed, dried and husked mechanically).

Preparations .. (*a*) Bhat.
(*b*) Panta.
(*c*) Monda.
(*d*) Khichuri.
(*e*) Bhuni Khichuri.
(*f*) Chal Bhaja.

(3) *Muri-chal* (Paddy, twice steamed and husked mechanically).

Varieties (*i*) *Alo-muri-chal.*

Preparations .. (*a*) Muri.
(*b*) Chal Bhaja

(*ii*) *Siddha-muri-chal.*

Preparations .. (*a*) Muri.
(*b*) Chal Bhaja.

NRE (paddy, macerated, slightly roasted and then compressed).

Preparations .. (*a*) Chinre Payes.
(*b*) Chinre Bhaja.

IV. Panchui, Handia, *etc.* (Rice saccharified and fermented by action of living organisms).

Varieties .. (*i*) Panchui.
(*ii*) Handia.
(*iii*) Kanji.

I. KHAI. LAI. PHARHI, LAWA DHAN (Sanskrit—*LAJA*).

Preparation. The paddy is roasted on sand (about 1 lb.) placed on the slightly concave floor of a *khola*, which is a conical earthen pot (about 12 inches high, 8 inches across the mouth and 12 to 18 inches across the base), from the side of which an entire strip has been carefully chipped away. This is heated on a wood or coal fire with a proper arrangement for regulation of heat to keep the temperature of the sand fairly constant. The heated sand is fairly constantly but gently stirred with a bundle of sticks or strips. newly cut from cocoanut leaves and used as a broom. When the sand reaches the proper temperature, which is tested by the immediate bursting of a small quantity of paddy thrown on it, about one or two ounces of paddy, previously slightly moistened with a little water or by exposure in the open air in the night for softening, are put on the hot sand and rapidly mixed with it. The paddy then bursts with leaps and sounds, as the starch swells into a spongy light mass. The starchy portion in this condition is called *khai*; the husks being either completely detached or remaining slightly adherent at their ends. The *khai* is mechanically separated from the sand and accumulated on the surface of it by a peculiar movement of the broom sticks and is then taken out from it. It requires a very skilful and well practised hand to take out the *khai* and husks from the bath, for one unskilled in the art will take out a considerable portion of the sand along with them or some of the husks and *khai* will be charred. In this way a large amount of paddy can be transformed into *khai* in a comparatively short time. For the preparation of good *khai*, rather big sized paddy is used, not less than a year old, otherwise all the paddy will not burst at the same time, or the resulting *khai* will be too small in size. *Kanakchur*, *Jhingeshal* and such other paddy are very commonly used for this purpose.

After the removal from the sand-bath or frying-pot the accumulated *khai* is rubbed on a piece of Hessian cloth, by which the adhering particles of sand become detached from it and collect by gravity on or below the cloth. The frier (*Bhajuni*) considers this sand a valuable article, as the older and more used the sand the better is the quality of the product. The next process is to sift the husks from the *khai* in a sieve of the following description. It is made of thin strips of bamboo woven at right angles to each other, leaving holes through which the husks only can pass. It is generally hemispherical in size ranging from 2 to 5 ft. in diameter. A sieve is half filled with crude *khai* and gently rubbed over with the palm of the hand in such a way as not to break the crisp *khai* and to leave a depth of about two inches of them between the palm and the sieve. The finished article thus obtained is stored in big dry earthen pots. The husks are used as fuel.

Properties and Uses. *Khai* is sometimes used as tiffin along with *murki*, *muri*, etc., but it is commonly prescribed as a main diet for sick persons, being regarded as a light and easily digestible substance. When fresh, it is chewed with pleasure, producing a faint cracking sound but if it absorbs moisture it becomes tenacious and then it is rather unpleasant to chew. *Lajapeah* (literally meaning a drink of *khai*) is a cold dilute aqueous extract of *khai* and is often prescribed as a light and easily digestible and stimulating liquid food, having an efficacy for stopping thirst and vomiting. *Lajabhakta* is prepared by mixing *khai* in hot water and is taken when cold. It is known as sweet, light, soothing, appetizing, tasteful, and soporific. When this preparation is filtered through fine cloth, the liquid portion called *Lajamonda* has essentially the same properties and is very frequently recommended by Kavirajes (Ayurvedic physicians) for children and old or delicate ladies.

Apart from the use of *khai* for edible purposes, it is almost indispensible in expressions of joy in connection with births, marriages, or the happy death of very old Hindus. The eighth day from the date of birth is celebrated by the free distribution of *khai* and other things to the children. In marriage it is used at different stages in different localities of the Province. If a man or woman dies at a good old age leaving a long line of heirs, a mixture of *khai* and coins are thrown on the streets along which the dead body is carried. Such a mixture is also distributed during the *Sradha* ceremony (end of the mourning period).

(1) MURKI. (*i*) *Murki* (with *gur*).

Preparation. A certain quantity of *gur* is taken in an earthen or iron *kara* (a hemispherical pot) and dissolved in a minimum quantity of water. It is gently heated over an ordinary hearth and the mass is constantly but slowly stirred with a wooden ladle having a flat end called *taru*. In this way it is brought to such a consistency as to feel sticky between the fingers and draw into threads, when the pot is taken from the fire and placed on a straw ring on the floor in an inclined position. A small quantity of any form of crystalline dry sugar (generally powdered palm-sugar is used) is dusted on the edge of the surface of the *gur* towards the centre of the *kara* and briskly stirred with a small portion of the liquid and then gradually the whole of it is gently mixed with it. This process is called *bich-mara*. Then a requisite quantity of *khai* is added to it by instalments and thoroughly mixed with the prepared *gur*.. Then the whole is massed together and kept in a cool place under the cover of a clean cloth. The object of the process of *bich-mara* is to introduce the nuclei of sugar crystals to the whole mass for hastening crystallization. While the crystallization is going on, the *khai* gets a thin layer of this *gur*, so the resulting product (*murki*) is coated with crystalline *gur*. This is a very ingenious and simple way of getting the *khai* coated with crystalline sugar. After a few hours the *murki* is taken out and transferred into a big dry earthen pot called *jala* and is then ready for use. In case the *murki* is not so dry as to be easily separable owing to bad manipulation or use of inferior quality of *gur*, some wheat flour is dusted over the product and it is then stirred and stored up. Sometimes flavouring substances such as powdered cardamom or cinnamon, camphor, etc., are added to impart their characteristic aroma and taste.

Properties and Uses. Good quality *murki* is a dry yellow, or amber coloured substance. Date molasses imparts to it a somewhat redder tinge than cane molasses; and also it has a very characteristic pleasant aroma for which it is often preferred to the other. *Murki* is usually eaten with *khai* or *muri* rather than by itself but some children having too much liking for sweets take it without anything to moderate its sweetness.

(*ii*) *Sugar-Murki.* For the preparation of this article white crystalline cane sugar is used instead of *gur*, and if the sugar is not very pure, the solution is clarified with dilute milk. It is a perfectly white, dry, and attractive article of food, rather costly, and is ordinarily used as a diet by patients under Kaviraji treatment. Both varieties of *murki* are at times used in a mixture with parched peas and gram, such mixture being called *fut-karai-murki* (fut = fried, karai = peas, etc.).

(2) KHAI-CHUR AND MOA.

The methods of preparation of these two are essentially the same as that of *murki*; only a higher proportion of saccharine matter and spices are used, and the *bich-mara* process is done after the addition of *khai* to it so that a considerable amount of it becomes broken into pieces. When warm it is taken in handfuls and made up into small balls which on cooling become fairly hard. The *khai-chur* maker from time to time rubs his palms with a little ghee or dusts them with flour to avoid stickiness. *Khai-chur* is generally made with sugar and *moa* with *gur*, but essentially there is no difference. These are used as sweetmeats.

II. CHAL, CHAUL (Sanskrit—*TANDUL*) English—*RICE*.

(1) ALO-CHAL (Sanskrit—*Atop tandul*).

Fresh or old paddy is freed from defective grains by uniformly spreading about five seers of it on dry clean ground about two feet in diameter and then blowing air on it with a *kula* (an instrument made of thin strips of bamboo used chiefly for winnowing). The defective paddy will separate off at a distance leaving the good grain. The process is repeated till several maunds of paddy are freed from dust and defective corn. Rice is prepared from this paddy when thoroughly sun-dried. The method of husking is almost the same as has been described by Sir G. Watt (*loc. cit.*), only it may be mentioned here that two men are not indispensable for this purpose; some clever workers can do it alone. In several places rice-mills are established where this work is done with much facility. From this rice, *khud*, *tunsh*, and *kura* are obtained. This rice is called *Alo-chal.*

Properties and Uses. *Alo-chal* is not eaten without some process of softening but may be offered in dry condition to Hindu gods and goddesses. For the latter purpose it is more frequently carefully washed with the holy water of the river Ganges and kept in the shape of a solid cone on a disc of wood, brass, copper, or silver. On the top of this cone there are often placed some sweetmeats called *naibedyas* which after the *puja* are distributed among the priests, together with the rice which is then transformed into *bhat* and eaten. The Hindus celebrate the new paddy of the year on a Thursday of the month of Agrahyan (from middle of November to that of December) which is called *nabanna* (means new-rice). *Alo-chal* prepared from very good quality of new paddy is mixed with various kinds of edible roots and fruits, milk, *gur*, and other sweets, and offered to gods and goddesses, after which it is eaten by all the members of the family; but until this ceremony is finished, orthodox Hindus will not eat the new rice in any form. Cold aqueous extract of this rice called *tandul-odok* (rice-water) is prepared by mixing rice or its powder with about four times its own weight of water and then filtering it, which is prescribed as a diet only to certain patients by Kavirajes.

Khud is the broken rice and regarded as a waste product. It is either given away as alms or utilized as a food for milch cows after softening it in water. It has a very nutritious effect on cows as they apparently give more milk when fed with this.

Tunsh is the husk of larger size; it contains rice oil (*Cf. Jour. Chem. Soc. Indi.*, 1893, 848). It is chiefly used as fuel, but it is also mixed with clay along with a little cow-dung for plastering purposes. *Tunsh* and clay plaster is very tenacious and does not crack on drying.

Kura or Gunra. This is a mixture of powdered husk and parts of rice. It is chiefly used as a cattle food and is specially liked by milch cows. If thrown into a pond in either the raw state or parched it acts as a most effective grain bait for fishing.

(a) *Bhat.*

Alo-chal is boiled for 20 to 30 minutes with about 4 to 5 times its weight of water. When sufficiently softened it is taken from the fire and the excess of water, which has become thick with some broken or loose particles of burst starch, is decanted off. This softened rice is *bhat*. It is taken out from the boiling-pot and spread on a plantain leaf, cotton cloth or metallic or stone plates for cooling if necessary, when it becomes ready for use. New rice has a tendency to soften too much; however carefully it is cooked or the temperature and time regulated, its gelatinizing property causes it to form lumps when cooled. The strained liquid is called *fan* and so is generally used as a drink for cattle.

Properties and Uses. Unless the *chal* itself is coloured, the *bhat* of *alo-chal* is as a rule white and very nice to look at. This *bhat* is regarded as more nutritious but less digestible than that from *siddha-chal*. It is generally eaten among orthodox Hindus who want to keep a closer touch with religion and want to live a pious life, by priests, old Brahmins, old widows, mendicants, and mourners. The reason for considering it as a suitable food for the pious is that it is practically a natural product, since as *chal* it has not undergone any process of cooking or steaming but is husked by means of mechanical treatment. The tendency of the Europeans to use this rice preferentially originates from the fact that its *bhat* is whiter than any other. The Indians believe it to be an approved an-aphrodisiac article of food. The only reason why this is not used as a staple food in preference to *siddha-chal* is that it is more costly than the other owing to the large amount of rice lost during the process of husking. *Fan,* under the name of *monda,* is prescribed as a diet for certain patients by Kavirajes when prepared with special care suggested by them. They regard it as an essence of *bhat* mixed with a little soluble starchy matter. Ordinary men find it difficult to digest and it is also supposed to contain more nutritious matter than *bhat.* Putrefied *fan* is sometimes used as a manure for certain creepers producing edible fruits. According to Chakra and Bhabprakash, when *bhat* is washed with water it becomes more digestible and it is a common practice among the Bengalis, when a man is suddenly attacked with diarrhœa or indigestion, to take *bhat* that has been previously steeped for some time and washed in cold water, because it is considered to become easily digestible by these processes.

(b) *Payes or Paramanna.*

There are about forty different recipes for the preparation of *Paramanna* (Param = good, high ; *anna* = rice). Generally very good quality *alo-chal* is selected for this purpose, *i.e.*, which has fine and clean grains and much aromatic oil in it. Generally the varieties known as *Banktulsi*, *Dadkhani*, *Kamini*, *Banshmati*, *Gopalbhog*, etc., are chosen. The rice is thoroughly washed and transferred into a pot and sufficient water added to cover the rice to the depth of an inch ; then it is very gently heated, no time should it be boiled briskly. When the rice is about half-softened so that the outer half of the rice is soft but the inner part remains as stiff as before, hot and half concentrated milk is added to it and gently stirred to mix it thoroughly. The quantity of the milk to be used varies considerably, depending on the quality of the produce wanted. Then a sufficient quantity of a sweetening agent, such as pure cane-sugar or cane or date-molasses is added. After gently boiling for a few minutes some flavouring substances such as cardamom, powdered cinnamon, camphor and some fruits like raisin, pistachio, almond, etc., are added.

Properties and Uses. *Payes* prepared with sugar is white but that with molasses is of pale brown colour. It is a mixture of thick syrupy liquid with *bhat*, emits either the natural odour of the rice or that of the spice added to it, and is a rich, delicious and tasteful article of food. As a rule it is not used daily by any class of people but it is almost indispensable on all festive occasions except those where preparations of rice are unallowable.

(c) *Polanna or Polaw.*

Polanna is a Sanskrit word and its method of preparation can be found in several old Sanskrit books. The other word *polaw* has probably been introduced by Mahomedans during their rule in India. It was a well-known favourite food of most of the Mahomedan kings and emperors. For this purpose good rice such as *Kamini, Banktulsi*, *Banshmati* and *Dadkhani* is chosen. *Alo-chal* is generally used but it can also be prepared with *siddha-chal.* The rice should be free from broken grains and should be at least two years old. There are more than 100 different preparations which may be classed under this heading, combinations in various quantities of various choice articles of food. The following description will only afford an idea of the general principle of its preparation. Good clean *chal* is gently rubbed with cow's ghee and saffron, and placed in the sunlight. As soon as the ghee soaks into the rice another coating of it is given. This is repeated till the process of soaking is complete. It requires a few hours preparation in sunlight. If prepared without colouring matter, the finished article will be called *ghee-bhat* and not *polaw* A decoction, called *aknir jal*, of several spices such as cardamom, cinnamon, cloves, coriander, etc., is now prepared whilst the rice is mixed with raisins, pistachio, etc. In a *dekchie* a layer of *tejpata* (cinnamon leaves) is spread with some ghee, then some pieces of fried fish, meat, or lumps of congealed milk with some of the rice are put on it. This is covered with another layer of *tejpata* and ghee, and similarly another of rice and *tejpata* is arranged on it. Next, the above prepared decoction is added till its surface rises about 2½ inches above that of the rice. To impart flavour, sugar, curd, salt, etc., are added in various proportions. The *dekchie* is now covered with a lid and gently heated over a bright fire. After about 20 minutes when the rice is not yet completely softened, it is removed and kept on a smouldering hearth, with some lumps of glowing charcoal on the lid, so as to keep the temperature of the *polaw* high for a considerable time to soften the rice completely, a process which is called *dom.* Sometimes delicate perfumes are added at the end, musk being formerly much used for the purpose.

Properties and Uses. *Polaws* are very delicious, fragrant articles of food. These are very nutritious and rather difficult of digestion, being commonly used among the rich classes, but only cooked by others on festivals.

(d) *Sofeda and Pituli.*

Good *alo-chal* is macerated with water for about twelve hours or more, then the whole is put on a new cotton cloth through which much of the water percolates out; it is then put on a piece of dry cloth which soaks up all adhering water. This rice is crumbled and the coarse powder is passed over a sieve of coarse cloth. The residue is again crumbled and sieved and finally a small part is neglected to be used as a cattle-food. The *sofeda* thus obtained cannot keep long unless perfectly sun-dried and stored in a dry pot. This is simply *alo-chal* powdered by a heavy grinding stone. Some people call it *chal-ata* (rice flour).

Pituli is a pasty mass of powdered *alo-chal* generally prepared only in small quantities by rubbing moist *alo-chal* with a little water on a rough stone surface with a similar stone roller.

Properties and Uses. It forms a white powder very much resembling flour. It is not directly used but it is the main ingredient in the preparations of *pithes*, *saruchakli*, *malpo*, etc. Now-a-days it is used as a fraudulent substitute for wheat flour in preparations of several good sweetmeats such as--*pantua*, *rasagolla*, etc.

(e) *Ruti.*

Sofeda is treated with boiling water in the same manner as in the preparation of *puli* (see later). The whole stuff is made into a solid ball by thorough rubbing and pressing. It is then divided into small balls of about ¾ inch diameter. These are next flattened into thin circular discs, and are subsequently roasted on a hot iron plate and these are known as *ruti*. Sometimes salt, sugar, etc., are mixed with it as fancy requires.

Properties and Uses. *Ruti* is a soft white substance and is not so attractive as several other preparations unless it is suitably flavoured; it is difficult of digestion and only occasionally used by Mahomedans and some up-country people.

(f) *Pithe or Pistaka.*

By *pithe* several preparations of powdered rice are meant; particularly (1) *aske* and *puli* or *siddha-pithe* or *chaka*, and (2) *puli*, *siddha-puli* or *chaka*.

(1) *Aske.* *Sofeda* is mixed with water to form a thin paste. About a fluid ounce of it is poured on a hot pan smeared thinly with a little mustard oil ; then it is covered with an earthen cup. After some time the cup is removed, when the cake is taken off with a ladle. This is *aske*. The object of covering is noteworthy. It retains practically all the water vapour by reverberatory process, and causes softening of the starch by continual steaming. If it were not covered the stuff would have dried before the softening of the starch grains. *Aske* is a white double convex cake having a taste like *bhat*. It is usually taken with *gur* or its syrup but may also be taken with curry.

(2) *Puli, siddha-puli or chaka.* *Sofeda* is gradually poured into boiling water stirring vigorously all the while till a thick paste is formed. When cooled it thickens and if it is not thick enough it may be made so with a fresh quantity of the powder. About half an ounce of this substance is taken and shaped like a cigar with a little dried milk in a solid state or some sugar preparation inside it. Several of these are put in a pot containing boiling water and very gently boiled for about half an hour, when they become ready for use. At some other places, however, they are steamed on a cloth tied on the mouth of a pot where some water is boiling. In this way the material is softened by steam under a cover of a lid above and direct saturated vapour below, for about an hour. The products obtainable by the two processes are practically the same. They are eaten on similar occasions as the *aske*, that is in the end of the Bengali month Poush, middle of December. The properties of *pithes* are similar to those of simple *bhat*.

(g) *Saruchakli.*

A thin syrupy paste is made of *sofeda* and water which is called *gola*. Sometimes salt, *gur*, paste of *dal* and wheat flour are added according to the taste required. The consistency at this stage has a very important effect on the finished product. About a fluid ounce of *gola* is taken in a small cup or spoon and poured evenly upon a flat frying pan previously rubbed with a little mustard oil or ghee on a slice of brinjal or potato. Then it is immediately spread to a uniform thin circular disc with a simple spatula of palm leaf cut like a knife-blade. After a short time when the lower portion of the disc, called *saruchakli*, is somewhat baked, it is lifted with a thin ladle, care being taken not to break any portion and then turned over for baking the other side. The ladle is then pressed on some parts of it so that the baking may be uniform, and when finished the disc is taken out and folded into a quadrant. This is one of the delicate preparations requiring considerable skill and practice.

Properties and Uses. *Saruchaklis* are sometimes as thin as paper but commonly they are made as thick as $\frac{1}{4}$ to $\frac{1}{8}$ inch. These are soft and are not generally eaten alone but with treacle or curry. Though not a delicious food yet it is taken as an alternative.

(h) *Malpo.*

Gola is prepared in the same way as above with additions of sugar, dried milk solids, spices, etc. About an ounce is poured on a hot bath of ghee and fried carefully. This is *malpo*, it is also prepared with curdled milk and other ingredients.

Properties and Uses. These plano-convex discs of about 2 inches diameter are a brown to yellow colour, of delicious flavour and commonly used as a sweetmeat.

(2) SIDDHA-CHAL, BHATER-CHAL OR BOILED RICE.

Paddy is cleaned as described under *khai* and macerated with an excess of water in large vats for about three or four days, then taken out and placed in an earthen pot or a tinned iron can, containing a small quantity of water which is heated till steam is seen to penetrate all the paddy. This process of steaming causes the husks to burst. The steamed paddy is then dried in the sun to a definite degree which is determined by pressing it between teeth. It is husked by the usual process. The products are *siddha-chal*, *khud*, *kura* and *tunsh.* The latter three by-products are used like those from *alo-chal* (q.v.). The finished article is then stored in gunny bags and is ready for market.

Properties and Uses. Siddha-chal has a characteristic transparent greyish white appearance in contra-distinction with *alo-chal.* It is less brittle than the latter. During the process of steaming before husking nearly all the grain is swollen and resembles *bhat* but it again contracts when dried. This is the cheap variety forming the staple food, *bhat*, of most Bengalees. Its *bhat* is believed to be more easily digested than that of *alo-chal.* It is more easily husked than the other and also with much less loss. This largely explains the preference shown for *siddha-chal*, but the rice produced is greyer than *alo-chal.* Probably this accounts for its being not used as a table-rice by Europeans. Its *bhat* can be softened to a considerable extent without that stickiness and gelatinization found in *alo-chal.* It is generally regarded as less nutritious than the other, but this is not completely corroborated by scientific experiments. There may be some truth in it because some of the nitrogenous matter may have been extracted and lost during the process of steaming.

(a) *Bhat.*

The *bhat* is prepared in the same way as that from *alo-chal*, only it takes a little more time to soften ; the older the rice the more is the time required for softening. The *fan* is also produced as before.

Porer bhat. This is prepared from old small grain rice by heating over a dim and slow heat produced by a heap of burning cow-dung cakes. In an earthen pot the rice with four times its own weight of water is taken and covered with an earthen lid and placed on the fire. It very slowly but steadily boils for not less than an hour, after which the pot is taken out. Generally the whole of the water added disappears by soaking and evaporation, consequently very little is left as *fan.* This food is regarded as nutritious, easily digestible and tasteful, and is chiefly used for children and invalids. These special properties it acquires by the slow and lengthy process of cooking so that all the particles of starch are completely softened.

(b) *Panta : Panta Bhat : Pakal Bhat.*

Bhat is prepared in the usual way, the *fan* being strained off. When it is perfectly cooled to the air temperature after three or four hours sufficient cold water is poured on it so as to cover about ½ inch deep. On keeping it covered for at least 24 hours it becomes ready for use. It retains its taste for two or three days. The fluid portion is called *amani* or *torani*, and the rice is called *panta*, *panta bhat* or *pakal bhat*. *Amani* may also be specially prepared in the following manner:—In a new earthen pot about half a seer of softened rice is taken and filled with pure water and after covering with a piece of cloth it is kept under the direct heat of the sun. Next day another instalment of fresh *bhat* is added and similarly left under the sun and so on up to three or four days. Then the clear transparent upper liquid called *amani* is decanted out and drunk.

Properties and Uses. *Panta* has an acid taste only, otherwise it is similar to fresh *bhat*. It is generally used by labouring classes who prefer it as cooling and refreshing. When eaten it is very often mixed with lime or lemon juice or with preparations of some acid-containing fruits and a little salt. The fluid portion, the *amani* or *torani* is used as a cooling drink and also sometimes prescribed as a diet by Kavirajes.

(c) *Monda, Fan, Mar.*

Monda is another name of *fan* as stated already. But the *fan* obtained as a by-product from the preparation of *bhat* is not quite similar to that described below. In a new earthen pot one part of washed, good, old rice is taken with 14 parts of water and boiled till completely softened. Then after straining out the *fan* it is mixed with one part of warm water and thoroughly ground in a mortar by a pestle. When it forms a pasty mass it is mixed with a fresh quantity of water and filtered through a piece of fine cotton cloth. The filtrate is the true *monda* to be used with a little salt, powdered ginger, and lemon juice. It is a very easily digestible, light and tasteful article of diet. Commonly, however, *fan*, *monda* and *mar* imply the same thing; the above is a special preparation used as a diet only by some classes of patients.

(d) *Khichuri, Kicharanna.*

There are no less than 30 different preparations of *khichuri.* These can be prepared either from *alo-chal* or *siddha-chal;* those with the former are not necessarily finer than with the latter. Commonly *siddha-chal* is used for this purpose, hence it is described here. The essential constituents in this preparation are *chal* and *dal* (pulse) ; they are mixed at different stages in various proportions. There are several preparations with fish and meat, but as a rule good *chal* and *dal* are used in its preparation. When rice is half softened by boiling, a quantity of *dal* which varies from one to four times that of the rice, is added. Next turmeric, raisin, pistachio, almond, sugar, ghee, salt, etc., are added. Sometimes fried fish, egg, meat, dried milk solid, etc., are added. When both the *dal* and rice are softened, the mixture is withdrawn from the fire immediately after addition of powdered spices. It requires much skill and care to cook it as here no *fan* is eliminated. There is a great chance of the mass charring and sticking at the bottom of the pot. In case there be any excess of water, the pot with the substance is placed over a smouldering fire.

(e) *Bhuni khichuri.*

There is another class of *khichuri* called *bhuni khichuri* (Bhuni = fried) prepared with *chal* and *dal* that have been fried after smearing with ghee; otherwise it is same as ordinary *khichuri.*

Properties and Uses. It has a pleasant appetizing odour, a yellow to brown colour, and a delicious taste. It is a rich food, difficult of digestion, commonly used as an article of luxury taken on some special occasions, *e.g.*, picnics, rainy days, etc. It is known to have a very heat-producing effect on the human system, so it is more frequently used in winter. Travellers often prefer it to simplify cooking. It is generally eaten while hot or warm, as the cold stuff is less tasteful.

(f) *Chalbhaja.*

Ordinary *siddha-chal* is moistened with a little water and salt and rubbed gently but thoroughly to give it uniform coating of salt, and then roasted on a sand-bath as in the preparation of *khai;* the product is called *chalbhaja.* This is also sometimes roasted in a hot iron kettle when the product is called *chalbhaja* of *kat-khola.* The preparation is hard and requires much chewing, is not very palatable, and also digested with difficulty. But when mixed with mustard oil, red pepper and a little salt it is relished by the labouring classes as also by healthy young people.

(3) MURI-CHAL.

There are two varieties of *Muri-chal* :—

(i) Alo-muri-chal ; (ii) Siddha-muri-chal.

(i) *Alo-muri-chal.* Paddy is taken in a basket and placed over a new unused pot containing some water boiling in it. Then the paddy is covered with a clean cloth; all the steam that comes out must pass through all the paddy. This process of steaming is continued for half to one hour. The grain is taken out and put into a large vat of water and allowed to macerate for three or four days. By instalments a large quantity of paddy is steamed. After maceration it is taken out from the water and steamed again as before, then dried and husked in the manner already described. The by-products, namely, *khud, kura* and *tush* are also similarly used as before.

Properties and Uses. This rice resembles *siddha-chal* in appearance. It is only used after its conversion into *muri* or *chalbhaja.* Its method of preparation is more costly than that of ordinary *muri-chal* and the products obtained from this rice are inferior to those from the other. The *muri* and *chalbhaja* from this rice are exclusively used by old Hindu widows who live on *alo-chal* only.

(a) *Alo-muri.*

Alo-muri-chal is washed with water and rubbed with a small quantity of salt, then transferred into a large shallow earthen kettle or *khola* and placed on a hearth. It is very gently heated, being constantly stirred with a wooden ladle. This process is called *onja*. At first the adhering water evaporates, then the temperature slowly rises and gradually all the rice becomes brown amber coloured. At this stage it is removed from the fire. In this process a considerable portion of the starch is probably dextrinized. Then it is usually parched on the sand-bath as described under *khai*.

(b) *Alo-chalbhaja.*

Chalbhaja from this *chal* can be prepared by dry heat, either with or without sand, and its properties are almost the same as those of *siddha-chalbhaja*.

(ii) *Siddha-muri-chal, muri-chal.* Clean paddy is taken in a fairly large sized earthen pot with about one seer of water and very gently heated till steam is seen to escape. At this stage the heat is carefully regulated so that steam only just escapes. It is kept in this condition for about quarter of an hour and then poured into a big earthen or wooden vat. When sufficient has accumulated it is covered with water to a depth of three inches. It is left in this condition for three or more days when it is taken out and steamed again, dried and husked in the usual manner. The rice obtained is called *muri-chal*. The by-products are also similarly used as stated before.

Properties and Uses. Muri-chal looks slightly darker than *siddha-chal*. It is solely used for the preparation of (a) *muri* and (b) *chalbhaja*. Of course it is not impossible to prepare *bhat* from this rice but its taste would be quite different from ordinary rice. Its *bhat* does not taste sweet as that from other rices. It is due to this special process of preparation in which the starch is so changed that its taste is quite different.

(a) *Muri.* For its conversion into *muri* this rice is treated in exactly the same way as *alo-muri-chal*. Bulk for bulk it swells more than the other. It is a greyish white, brittle and dry substance, and is an easily digestible, light food. In villages it is prepared by each family for its own consumption and is also prepared in quantities by sweetmeat makers and vendors. It is used as a cheap and easily procurable article of tiffin. Almost all healthy village people, young or old, rich or poor, use it for this purpose. It may be taken as it is or smeared with a little mustard oil, red pepper and salt, followed sometimes by *gur* or sweetmeats.

Muri is appreciably hygroscopic ; when exposed to damp air it rapidly absorbs moisture and loses its brittleness and then it is not readily chewed and is rather unpleasant. In this condition it does not crackle in the mouth and is called *miono-muri*, 'miono' meaning soundless.

Muri is sometimes mixed with milk, curdled milk, plantain, mango pulp, etc., before eating. Such mixtures are called *falhar*. *Falhar*, however, can also be prepared from *khai* or *chinre*.

Muri-chak and *muri-moa* are prepared just in the same way as *khai-moa*. The *muri-chak* is shaped into thick circular discs and the *khai-moa* into balls.

(b) *Chalbhaja*. *Chalbhaja* from this rice can be prepared by the same method as *chalbhaja* from other rices, but this variety is more tasteful and easily digested. This stuff is used like *muri* but less frequently. It is very seldom taken alone, being always mixed with parched grams, peas, etc., and smeared with mustard oil, pepper and salt. In Calcutta there is a common and well-known preparation of *chalbhaja*, called *abak jalpan* (*abak* dumfoundered ; *jalpan* = tiffin, *i.e.*, a food so good that one is dumfoundered). This is chiefly a mixture of good *chalbhaja* with parched peas, grams, etc., flavoured with mustard oil, red and black pepper powder and several other spices. It is sold as one pice paper packets folded to form a solid cone. It is a tempting substance specially to children who take it in the afternoon.

Gunda literally means powder ; but powders of *muri* or *chalbhaja* are called by this name. It is generally eaten with molasses or treacle, and is also sometimes prepared from fried *khud* for economy. It is not ordinarily sold in the market but prepared for family use.

III. CHINRE, CHIRA, CHURA (Sanskrit—*CHIPITAK*).

Any paddy is taken and steamed in an earthen pot as previously described, and then macerated in a vat of water for two or three days. Then it is taken out from the water and kept in a basket so that the adhering water drains away. When drained, it is transferred to the *dhenki-sal* or husking-machine adjacent to which a hearth is ready with a sand-bath on it. It is heated in the sand-bath until there is evidence of parching, *i.e.*, a little *khai* is formed. Then it is immediately taken out on a *kula* and freed from sand by winnowing and at once subjected to the working of the *dhenki*, while still very hot. The *chinre* is purified from the *tunsh*, etc., which are eliminated by the usual process. The preparation of *chinre* requires the utmost skill so much so that it is still restricted to a particular class of people called *chutar*. This work is generally performed by women; all the operations are finished while the *chinre* still remains sensibly hot, it is then air-dried or sun-dried if necessary and stored up in gunny bags, or big earthen or wooden jars.

Arwah chura or *arwah.* In certain places paddy is allowed to soak completely in water (for three or more days) then partially dried in the sun, heated and crushed by the *dhenki* or by some similar means and cleaned. The *chinre* thus obtained is called by the above names. This can also be made with half ripe paddy.

Usna chura or *joshanda* is prepared by steaming or boiling paddy with water and partially drying under the sun; it is then usually bruised in the *dhenki* and cleaned.

Properties and Uses. Chinre is a fern-like flat greyish white substance corresponding in colour to the rice used. When steeped in water it considerably swells up and becomes as soft as *bhat* or sometimes softer. It may be then eaten with *gur* or some such sweetmeats, but it is most pleasantly eaten after mixing with the various tasteful substances noted already under *falhar*. It is a valuable article to travellers and orthodox Hindu tourists or pilgrims, as it can be readily prepared for food without cooking; besides it has a special advantage that it is not more costly than *bhat*.

Water of chinre is a cold aqueous extract of *chinre* prepared by simply steeping it in water for a certain length of time. The clear water is decanted off with the greater part of the soluble matters (sugars, soluble starch, etc.) in solution. This is regarded as a valuable diet for patients suffering from some stomach diseases.

(a) *Chinre Payes.*

One part of sugar or *gur* and about 8 parts of milk are boiled for about 20-30 minutes for concentration, then a very good quality of *chinre* is washed and put into it. When this just commences to boil, it is taken from the fire and kept in a warm place. This is used on the same occasions as *payes* made from *alo-chal* and is equally delicious. To it also raisins, pistachio, sweet almond kernel, and spices are added.

(b) *Chinre bhaja.*

It is prepared in the same way as *muri* by parching *chinre* on a sand-bath. It is used instead of *muri* but less frequently than the latter. It is also often used in a mixture with several other fried substances.

Chinre chak is a preparation corresponding to *muri chak* prepared. sold and used side by side with it. It is a good substance to be taken at the tiffin time if prepared with proper care.

IV. PANCHUI, HANDIA, AND KANJI.

Preparations of alcoholic drinks from rice starch appear to be of relatively modern origin. In early days they were chiefly obtained from saccharine juices of fruits and trees and from *gur*. Among rice preparations containing spirit (i) *panchui*, (ii) *handia* are very well-known. For their preparation rice and *bakhar* or *ranu* only are necessary. Any kind of rice is used, the *bakhar* is purchased as greyish cubes, balls or simply lumps. This first converts the starch into sugar and then to alcohol. The English synonym for *bakhar* is generally accepted as yeast which is scientifically unsatisfactory as yeasts are those which convert invert sugar into alcohol but *bakhar* is also a saccharifying agent.

(a) *Panchui.*

Bhat is prepared in such a way that the grains do not gelatinize or stick together. The *fan* is strained out if necessary and the *bhat* is spread on a piece of cloth or on plantain leaves for cooling. While it is still warm, *i.e.*, slightly higher than blood heat, the *bakhar* is spread over it and roughly mixed together and stored in a pot. It is then kept covered in a warm place for 24 hours. During this time a considerable part, if not all, of the starch is transformed into sugar. In certain places it is diluted at this stage while in others it is kept as it is and diluted after five or six days. After the fermentation is complete it is sometimes further diluted; then by filtration or by decantation clear liquid is obtained for drinking purposes. The undiluted substance is called *panchui* and the diluted one is called *rashi* but this nomenclature is not general.

Properties and Uses. Panchui is in fact a rice beer from which pure spirit can also be obtained. It has a pale yellow to brown colour and a very characteristic acid odour. Its alcoholic strength varies from any low figure to as high as 39 per cent. proof spirit, whereas in ordinary fermented liquors it scarcely rises above 23 per cent. proof spirit. This is mainly used by lower classes of people who cannot afford to purchase costly liquor.

(*b*) *Handia.*

This preparation is made and taken by the comparatively poorer classes of *dhangars* (sweepers), etc. This is very similar to *panchui* and the mode of preparation is also the same as that of the latter, excepting that instead of freshly boiled rice, refuse boiled rice (sometimes even partly decomposed) is somewhat dried in the sun and the *bakhar* subsequently added.

Although the finished product is relished by its users, yet it has much more of the putrid smell than ordinary *panchui*, as in the former there is a lot of decomposed food matter besides the rice.

(*c*) *Kanji.*

(Sanskrit—*Kanjik*).

This is prepared by steeping 2 seers of powdered *aus* paddy (an early growing variety) in 8 seers of water in a pot which is kept covered and buried under earth. It is kept in this condition for at least 15 days and the clear liquid decanted out. It has an acid taste and odour like acetic acid. Dr. U. C. Dutt in his *Materia Medica of the Hindus*, page 12, while describing *kanji* has not dealt with the chemical processes of the fermentation of acetic acid, but only stated that sour liquid is produced by the acetous fermentation without any mention as to whether any alcoholic fermentation takes place at an intermediate stage.

Probably its compositior is similar to malt vinegar. It is directed to be used as a cooling and refrigerent drink in fever. It has a soothing effect on burning skin. It is generally used by Kavirajes as a vehicle for medicines.

V. CONCLUSION.

The proper conclusion of such a paper would have been remarks about the comparative merits of the different preparations, but unfortunately no scientific data are available for that. In many instances the properties of preparations have been taken from authors of Kaviraji Shastras such as Chakra and Bhabprakash. There is a correct notion that the digestive properties of different rices are different, and that an old rice is more easily digested than a new one of the same variety. The starch is considerably swelled up in *khai,* its exact nature is not known. It is highly needful to settle the real merit of such preparation as food. Regarding the varieties of rice—*alo-chal, siddha-chal, muri-chal* and *chinre,* chemical examination could really ascertain how far they are different.

The need for slow heat in cooking has been realized in the preparation of *porer bhat,* and in producing *dom* of *polaw,* etc. For these purposes steam-bath could be recommended for convenience and perfection. Cooking by steam-bath has already been introduced by Dr. I. M. Mallik whose patent apparatus is called the "Ic-mic cooker"; to popularize this Dr. C. L. Bose in his book "Khadya" (food-stuff) has amply described its use. By the adoption of such a method improved results are expected in cooking *bhat* for infants and invalids and in preparing rich, delicate and fanciful preparations like *khichuri, polaw,* etc.

Among the liquid preparations from rice nothing is known about the chemical constituents of *amani* and *kanji.* The *panchui* and *handia* are used as spirituous preparations but they contain extractives, etc., other than alcohol. At present the spirit obtained from rice starch is called *dheno-mad* (dheno = from, paddy;

mad = intoxicant or intoxicating liquid). If the rice spirit has all along been prepared from rice and not from direct paddy then its name more probably would have been *chalo-mad* instead of *dheno-mad.* This naturally suggests that preparations of spirituous liquids could be directly started from paddy, either by powdering or by macerating and steaming without passing through the intermediate process of husking. In that case spirit could be obtained at a much cheaper rate. It is not known whether any attempt has been made to prepare spirit from *khai, muri,* and *chinre.* The first two are expected to imitate malted beers. The facts in favour of the last are that it is of about the same price as its equivalent rice and it does not require boiling for softening, simple steeping being sufficient.

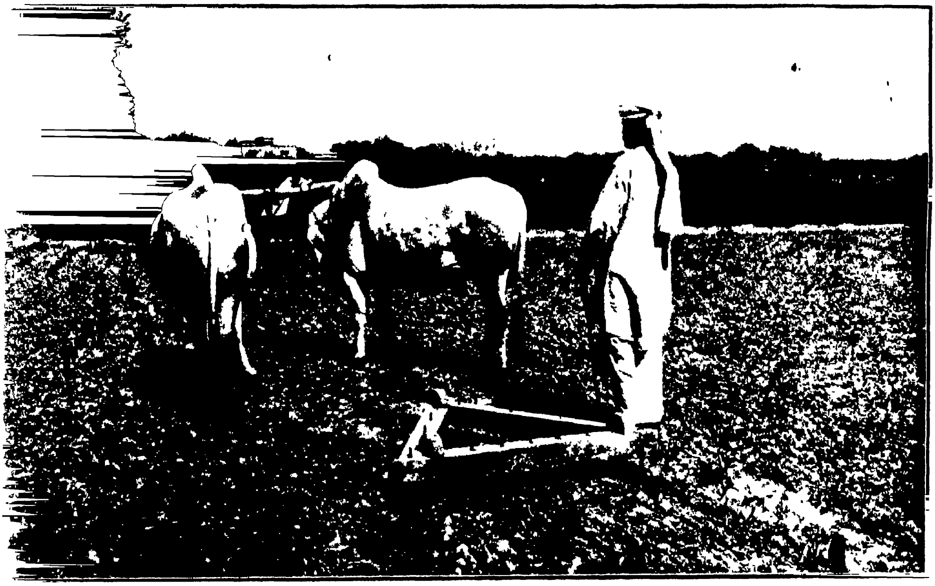


Fig. 1. Harrow at work.

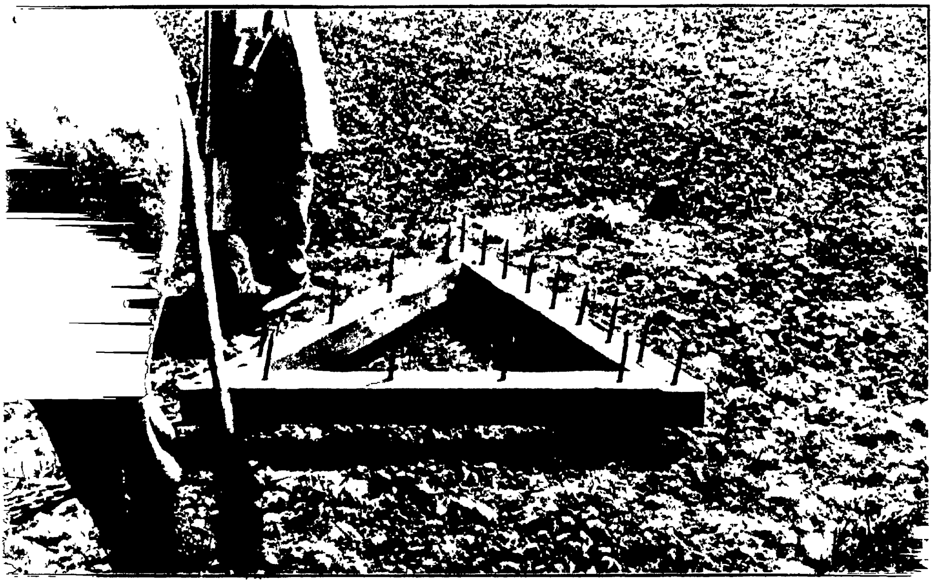


Fig. 2. Harrow reversed for taking off the field.

NOTE

A TRIANGULAR HARROW FOR WHEAT. The harrowing of young wheat has engaged attention at Lyallpur since 1910 when Milligan tried the Parmiter Chain Harrows here. Some benefit was immediately observable in that the wheat tillered better and became more robust after harrowing. Less danger of white ants attacking the crop was also observable as the latter do not relish vigorous growing plants. Later in 1911 and 1912 some Chain Harrows were tried by zemindars here and also in Gurdaspur. While admittedly some benefit was obtained the price of the Harrow, *viz.*, Rs. 65 at Lyallpur was a great deterrent to its extended use. It was found also that though good results were obtained on light land and on all land before the first irrigation or "kor," the Chain Harrow was not sufficiently strong to break the crust after irrigation. In the last two years we have used the Lever Harrow here, this having given good results with Howard in Bihar. This harrow did better work than the Chain Harrow, and owing to the possibility of adjusting the tines to slope slightly backwards or forwards was better able to tackle wheat during "kor" (*i.e.*, before the first watering) than the Chain Harrow. It was found, however, that even with two harrowings very little effect was obtained generally on irrigated wheat. Besides, the price which in Lyallpur was Rs. 37 was somewhat heavy, especially as these harrows are of special use only for this one operation. Four acres a day can be harrowed once with the Lever Harrow as compared to seven or eight with the Chain Harrow. It was felt therefore, that the problem, being an economic one, a cheaper harrow had to be evolved. The best design for this purpose proved to be an adaptation of the Triangular Harrow first seen by the writer at Coimbatore in 1913. Some of its advantages are described by Sampson in the *Agricultural Journal of India,* Vol. III, Part I, January 1908.

The type finally adopted here this last autumn and which has done excellent work is shown in Plate IV.

The following points about it may be noted :—

(1) It can be made by local carpenters in the villages. The cost is Rs. 6 at Lyallpur.

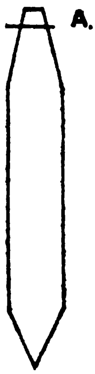
(2) The tines slope slightly backwards ; about 12° is ample.

(3) The weight for young wheat should not be more than 30 seers.

(4) After first irrigation the harrowing is more severe and extra weight should be added. Twenty seers is generally added here.

(5) The tines are specially hardened by the native process known as "Pan."

(6) The tines should be pointed and should be tapering in the part passing through the wooden frame. If this is not done, the pegs are apt to get loose in the wood (*see* Diagram). They are secured from falling out by a pin at A.



(7) The harrow has only 17 tines as compared to 30 in the Lever Harrow and thus deeper harrowing is possible and very often one harrowing suffices in place of two with the Lever Harrow.

(8) Four acres a day can be harrowed once with it.

(9) For taking the harrow off the field, it is only necessary to reverse it when it travels on the rests at the three corners.

It was found that wheat could be harrowed at any stage up to 8″ high with these harrows without doing appreciable damage and with very good effect on the general health of the crop. This harrow can also be used for gram with beneficial results.

[W. ROBERTS.]

⁂

TEFF GRASS.—In the Cawnpore Farm Reports for 1914 and 1915 figures are given for the yields obtained with Teff grass (*Eragrostis abyssinica*) when grown as a cold weather irrigated fodder crop. It is shown that in favourable circumstances a yield of approximately 1½ tons of hay of good quality, or 5—6 tons green fodder can be obtained between December and May at a time when green fodders are frequently scarce. Teff grass is a quick growing crop and is, therefore, of great use in irrigated tracts, when there is any shortage of fodder. Sown at the beginning of December, it yields its first (and heaviest) cutting about the middle of March and a subsequent cutting at the beginning of the hot weather. Experimental work with this crop is still going on, but it has been found desirable to publish the present note as some confusion has already arisen between the different varieties.

The Kew Bulletin of Miscellaneous Information, No. 1 of 1913. contains an article on Teff by Mr. Burtt-Davy, Government Botanist to the Union of South Africa. Describing the progress which has been made with Teff in Natal and the Transvaal, incidental reference is made to previous trials in India, notably by Duthie at Saharanpur in 1888. The results given by Duthie were promising, but no further progress appears to have been made; probably for the reason that the Teff was tried as a hot weather and rains crop and possibly also because the wrong variety was obtained. Two varieties of Teff have been tried at Cawnpore, *viz.*, *Teff Tseddia*, obtained from South Africa, and *Teff Hagaiz*, obtained through the kindness of the Director of Kew. A third variety known as Nach Teff appears to exist in Abyssinia, but up to the present the writer has been unsuccessful in attempts to obtain seed.

Of the two varieties tested at Cawnpore *Teff Hagaiz* proved to be useless. It is a variety with a long growing period and failed when grown in the cold weather. Sown in the rains, it took over four months to mature and the yield was not good enough to justify its cultivation in place of such excellent fodders as ordinary *juar*.

Teff Tseddia, on the other hand, as already mentioned, gave very promising results when sown as an irrigated cold-weather fodder. Seed of this variety is obtainable from the Agricultural Supply Association, Johannesburg, who were recommended to us by the Union Department of Agriculture.

As regards cultivation, Teff grass is suitable for light and medium soils. The South African Department recommend sowing it with a grass drill at the rate of 5 to 7 lb. per acre. At Cawnpore, on land irrigated prior to ploughing, Teff germinated well when sown broadcast at 7 lb. per acre and lightly harrowed in. It is desirable to mix the seed with sand or dry earth to facilitate even distribution. Imported Teff seed is expensive, but good seed is easily saved at Cawnpore. Up to the present seed has been taken from the second cutting only; this was not so bold as the imported seed, but germinated well in the following year and gave a satisfactory crop.

An analysis of Teff hay, kindly furnished by Mr. Clarke, Agricultural Chemist, United Provinces, is inserted for comparison with the Transvaal analysis.

	Cawnpore	Transvaal
	%	%
Water	6·95	8·88
Protein	4·06	6·21
Fat	2·01	1·21
Carbohydrates	51·43	39·08 (Soluble.)
Fibre	29·35	39·07
Ash	6·20	5·55

[B. C. BURT.]

⁂

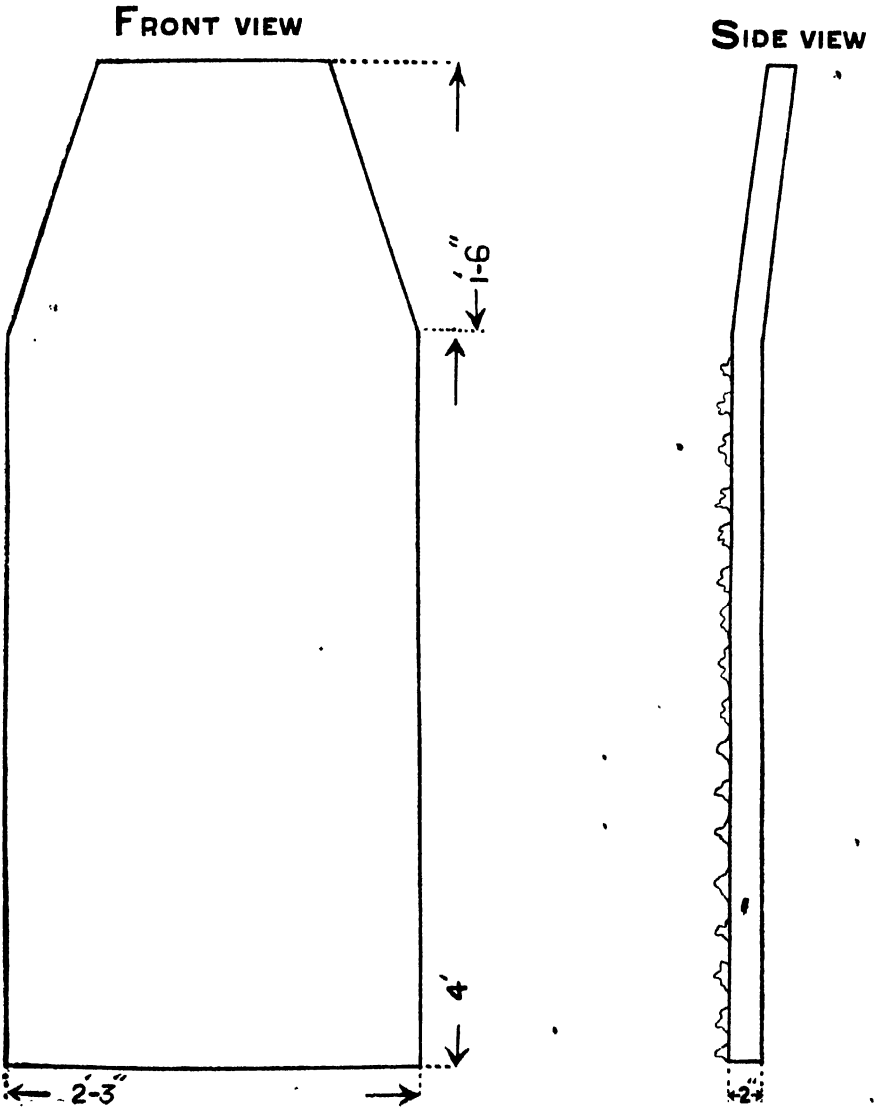
WE have received from Mr. H. A. Casson, C.I.E., I.C.S., Commissioner, Lahore, for publication the following description of a thresher used in Turkey in Asia which was supplied to him by the Rev. A. E. Harper of Sharakpur.

Plate V shows the thresher at work. Flint stones with sharp edges are fixed on the bottom of the implement, one stone for

PLATE

RESHER SED IN TURKEY IN AS AT WORK.

every two square inches and each stone about one inch square and $\frac{3}{16}$th inch thick in centre. The two diagrams below indicate different parts, in detail. The implement is in common use in Turkey in Asia and is considered very efficient. In India iron can be substituted for flint.



Scale. 1 inch=1 foot.

PARTIAL STERILIZATION OF THE SOIL. A COMMON PRACTICE IN THE SHAN STATES. Whilst the work of Russell, Petherbridge, Hutchinson and Pickering (*Journal of Agricultural Science*) has lately proved the value of partial sterilization of the soil by heat and opened the way to further investigation of its effects, a process of soil heating exists as an old established practice throughout the Shan States and is considered indispensable to almost all forms of dry-crop cultivation.

Apart from "Taungya" cultivation, which no doubt owes a very great deal of its success to the sterilization which results from the burning of the dried jungle growth on the surface of the soil before any cultivation takes place, the cultivator of the Shan States assiduously sterilizes his soil for almost every crop which he puts down, but more particularly for hill paddy and for potatoes.

It has been the practice for ages on the extensive red loams or clay-loams—which are derived from the limestone and with which the greater part of the cultivable country is covered—to collect the surface soil into small mounds and to subject it to heat before the crop is planted. The process is going on over large areas throughout the whole of the dry weather.

The surface soil is first loosened to a depth of 2 or 3 inches (seldom more, often less) with a plough drawn by a single buffalo or sometimes by manual labour with a form of hand hoe. The dry lumps are then broken up by beating with a mallet or by the hoe and the soil pulverization completed by further hoeing. The loose soil is then heaped up into small low mounds with crater-like centres—one mound appearing about every 4 feet each way.

The dried vegetation collected on the same land is placed in the "crater" of the heap, but vegetation is extremely scanty and the principal fuel used is dried cattle dung of which a small lump is placed in the centre of each mound. Villages, roads, caravan camping-grounds and even the wide pasture lands are scoured for cattle droppings which are carefully collected, carried to the fields (usually in baskets slung on a yoke over the shoulder) and dried for use in this operation.

When burning is in progress the fuel is allowed to smoulder only and the heaps (of which only a very few are started at the same time) are carefully tended and heaped up so that a maximum of soil may be subjected to the heat. The fuel continues to smoulder for a long time during which the surrounding soil is continually being pulled up on to the top of the heap. On completion the centre of the mound has the appearance of burnt, broken brick. It is surprising what a large amount of soil may be heated in this way with a small amount of fuel and what a large area a single cultivator and his family are able to prepare.

If the land be for paddy, after cooling, the heaps are spread by means of the hoe over the surface of the land, but if intended for potatoes the " sets " are planted in the mounds—three or four small ones in each.

The cultivator believes the process to be essential to the success of his crop, and there is little doubt that by far the greater part of any benefit derived therefrom is due to the heating of the soil, for the amount of manure ashes added is so small as to be almost insignificant.—[E. THOMPSTONE.]

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THE SUPPLY OF AGRICULTURAL IMPLEMENTS BY CO-OPERATIVI SOCIETIES.—Great developments have recently taken place in England and Ireland in the establishment of co-operative societies for the supply of agricultural implements and in many cases societies have been formed especially for this purpose. The system adopted has been for the society to buy from its capital certain implements required by members and to lend these to members on hire. The rates of hire have been fixed high enough to give an appreciable profit and to enable the cost of the implements to be quickly recovered, the receipts so obtained being credited to a general fund with which further implements are purchased as soon as possible. In this way after a few years' working, several of these societies have found themselves in possession of a considerable number of improved implements. And the scheme has not only worked successfully from a financial point of view, but has been of the greatest assistance to members, either by allowing them to bring larger areas of land under valuable crops, or by enabling them to effect economy in labour.

Agricultural implements may be roughly divided into two classes: those which are merely labour-saving and those which enable cultivation to be carried out more effectively than previously. There is, however, no strict line of demarcation between the two classes as many labour-saving appliances permit of better cultivation by enabling operations to be carried out at the most suitable times.

With small holdings, which are the rule in this province, the demand for expensive labour-saving appliances is necessarily small, but even so, there is a steady demand for such implements as chaff-cutters and improved water-lifts, while there is a larger demand for inexpensive ploughs and cultivating implements which enable cultivation to be carried out more thoroughly than with any indigenous implements. It is obvious that even when freed from debt and placed in a comparatively sound financial position, there are many of these implements which it would hardly pay an individual cultivator to purchase for himself as he would not use them sufficiently often to justify their purchase. On the other hand, there are few village banks which would not benefit by the co-operative ownership of a number of improved implements.

In the past the Agricultural Department has placed small stocks of certain implements at the disposal of central banks for the use of their members. These implements have in some cases been sold direct or given on hire, or in other cases have been sold to members on the instalment payment system. In this way no insignificant number of the cheaper implements, such as Meston ploughs, have been introduced. The arrangement, however, is essentially a temporary one made for demonstration purposes and is one which cannot be indefinitely extended. It is now suggested that certain banks might go a step further and purchase small stocks of implements for the use of their members as well as maintaining a small stock for sale to those members who can afford to buy them. Amongst implements which members might eventually own individually, we may mention such inexpensive implements, as the

Meston plough, but there are far more examples of implements of which one or two would be sufficient for the whole of the village, and which might be given by the village society to its members on hire.

The best example is probably afforded by sugarcane mills and *gur*-boiling pans. That there is considerable profit in this business is evidenced by the fact that throughout this province small agencies are found where iron sugarcane mills are given on hire with or without a *karhao*. The hire charged varies very much, depending partly on the initial price of the mill and partly on the local demand, but it is no uncommon thing to find petty contractors charging as much as Rs. 25 per season for the hire of a sugarcane mill, while in some cases as much as Rs. 40 has been charged. In other villages where mills are given on hire by local men it is frequently the custom to charge Rs. 5 per acre of sugarcane crushed as hire for the *kolhu*, sometimes with and sometimes without the *karhao*. Considering that a very good three-roller mill can be obtained for about Rs. 86, which will last for at least ten years with care, it is obvious that there are considerable profits to be made. Many of the mills given on hire in the bazaar are inefficient and cause a loss varying from one-fifth to one-third of the extractable juice. Such mills can be purchased for Rs. 25 to Rs. 30, but a little consideration will show that, apart from the fact that they frequently get out of repair, a mill of this kind is dear at any price. It would be quite a feasible proposition for a central bank to own (say) 20 first-class three-roller sugarcane mills and to give these on hire to village societies for the use of their members. The central bank would generally be in a position to make arrangements for the annual overhauling of the mills and the re-turning and re-grooving of the rollers; but should any difficulty arise the Agricultural Department could assist them in this matter. It would also be necessary for the central bank to maintain a small stock of spare parts, so that mills might be kept in order, and it would also be desirable that they should keep during the crushing season an ordinary *mistri*, who could go round and see that the mills were kept in adjustment and were not being mishandled.

Another agricultural implement, in this case really labour-saving, which has caught on throughout the province is the chaff-cutter, but here again it is obvious that only a man possessing five or six pairs of cattle can make it worth while to own one himself and most of the chaff-cutters sold through the Agricultural Department are being supplied to cultivating zemindars, many of whom also give facilities for their use to their cultivators. A chaff-cutter costing from Rs. 40 to Rs. 50 is capable of cutting sufficient fodder for 15 to 20 pairs of cattle; it is obvious, therefore, that one or two chaff-cutters would meet the requirements of a single village society. It should not be beyond the powers of a flourishing village society to work out a hire scheme, by which a jointly-owned chaff-cutter could be used by all the members. Assuming a society to consist of 20 members each owning a pair of bullocks, a fee of annas four per month throughout the year would more than pay for the chaff-cutter in a single year, whilst a fee of annas four per month restricted to the *chari* and *karbi* season would enable the chaff-cutter to be paid for in two years and would leave a handsome margin for the provision of new knives when required and to meet any repairs necessary.

As a third example may be quoted the case of special ploughs. It has already been suggested that the ordinary Meston plough is sufficiently cheap to enable individual members to own it, though there will be no objection to a few such ploughs also being jointly owned by small village societies, where the holdings are small. In the case of larger ploughs and special purpose ploughs, for details of which reference may be made to the pamphlet on ploughs and ploughing, published by the Department of Agriculture, United Provinces, one or two ploughs would probably be sufficient for a village bank. These ploughs vary in price from Rs. 25 to Rs. 50 and, as in the case of the chaff-cutter, a very modest rate of hire would soon bring in enough money to pay for the plough. In certain districts, for example, large ploughs are required for ploughing out deep-rooted weeds, such as *bainsura* and *kans*. Experiment has shown that if these weeds can once be got under by thorough ploughing, their complete eradication is merely a matter of time and patience, but ordinary cultivators do not possess the means of deep ploughing and their only alternative is the very expensive process of digging by hand. With one large plough in a village, owned co-operatively, small areas could be done each year until the pest was eradicated, whilst in the case of ploughs requiring more than one pair of bullocks the co-operative ownership of the plough would stimulate members to help each other by the loan of bullocks in turn. Another plough may be mentioned, which although not heavy to work it, is expensive to buy, *viz.*, the steel-bar-point plough (Pathartor or Sabul plough), which can be used for breaking up hard land without irrigation. By using such ploughs it is possible, even when there is no rain, to plough cotton and *juar* stubbles during the cold weather, thus improving the yield in the subsequent year and doing much to eradicate insect pests. It would be easy to multiply instances of improved agricultural implements which might be owned co-operatively. A new list of implements with prices has been published by the Agricultural Department, United Provinces, and it is for co-operative banks to select those which meet their requirements. The object of the present paper is to point out the great possibilities the co-operative ownership of implements opens up.

In conclusion, stress may once more be laid on the principle which was enunciated in connection with the establishment of co-operative seed stores, *viz.*, that all such transactions must have a cash basis, and further that members obtaining seed or implements from either a village society or a central bank must be just as prompt in payment of their dues—whether for price or for hire—as in the repayment of cash loans. This has not always been understood in the past where the Agricultural Department has supplied seed or implements to central banks for the benefit of the constituent societies. Any slackness in this respect is opposed to the fundamental principles of co-operation, and it is, therefore, necessary that managers and *sarpanches* should insist on the same scrupulous care in the repayment of money due for seeds or implements as in the case of cash loans. It is also desirable that central banks should adequately realize their responsibilities in such matters.—[B. C. BURT.]

Note.—This paper was originally read in vernacular at the Co-operative Conference held at Lucknow in February 1916. It is somewhat of local interest, but it was impossible to remedy this without recasting the whole paper. It is, however, published here in the hope that it may prove of some utility to workers in the same field in other provinces.

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SALE OF MANURES BY CO-OPERATIVE SOCIETIES.*—The extent to which the use of certain manures, chiefly cakes, such as castor cake and *nim* cake, is growing in those parts of the provinces where intensive cultivation is carried on, is not fully realized. For instance, castor cake is very widely used for potato-growing round Fatehgarh and is gradually extending beyond the borders of the Cawnpore District. In parts of the Meerut District *nim* and castor cake are popular for potato-growing and for chewing-cane. One cultivator, in the latter area, informed the writer that he had spent about Rs. 50 on manuring his cane field with castor cake, and he found that it amply paid him to do so. Intensive cultivation for the production of vegetables, etc., is spreading round the large towns and would undoubtedly increase more rapidly but for the difficulty in procuring manures, without which it cannot be carried on. Some of the large towns, such as Cawnpore and Benares, dispose of their sewage by putting it into the nearest river; while in many of the smaller towns little use is made of the available supply, owing to objections in handling it. The market for the sale of manurial cakes, such as those mentioned above, is at present very imperfectly organized; prices fluctuate largely and sometimes it is by no means easy to procure them at all. Much of the castor cake pressed in these provinces is under normal trade conditions exported; though judging from the quoted prices, there is very little, if any, more profit to be obtained from the export than from internal trade. The crushing of *nim* for oil seems to be almost entirely a village industry and, while the cake is cheap in some parts of the provinces, it is almost unprocurable in others. The Agricultural Department, though willing to pay good prices for these cakes for sugarcane growing, often find it difficult to buy them, owing to the lack of organization in the market. Looking to the small quantities of poudrette procurable and the objections that many cultivators have to using it, these cakes seem to offer one of the best forms of manure for common use. They possess in varying degrees the valuable constituent of nitrogen, which is mainly required in the soils of these provinces, and they are far cheaper than what are ordinarily known as artificial fertilizers. An attempt is also being made to popularize the use of these cakes from another point of view. There is a very large export trade in oil-seeds from these provinces, and there is *primâ facie* no reason why some portion should not be crushed in these provinces and a valuable industry thereby opened up. Many of these oil-cakes form valuable feeding stuff for cattle, while some, such as *mohwa* cake, should be useful for manure. The difficulty however in starting such industry has hitherto been the absence of a regular market for the cake, without which it does not pay to crush. A grant has recently been made by Government for popularizing the use of these cakes and the greater part of the grant is being devoted to putting out manurial cakes, principally *mohwa*, the use of which is little known in these provinces. In some instances the cake is being distributed through co-operative societies to their members. If it is appreciated, the foundation should be laid for a regular sale of this cake, which is now procurable in fairly large quantities, to cultivators. This will serve the two-fold purpose of establishing an industry and providing a means for improving the cultivators' crops. The need for some regular supply association for the provision of these manurial cakes has already been pointed out. If, as is to be sincerely hoped, their use becomes more common, the co-operative societies could very well undertake their sale. In Europe the supply of manures is one of the largest business of the agricultural co-operative societies, and it is a very profitable one to the societies. There is a wide margin between wholesale and retail rates, and the manufacturer is generally willing to sell cheaper in large quantities. It may be mentioned that a firm engaged in oil crushing in these provinces offered to sell *mohwa* cake at 2½ annas per maund, instead of 4 annas, if taken in quantities of over 10,000 maunds. This would permit the society to sell below market rates and still retain a handsome profit. In other parts of India rather more progress seems to have been made. At the last meeting of the Board of Agriculture it was stated that "In the case of manure societies, a notable success has been achieved at Kelva Mahim near Bombay where in a tract of very intensive culture, with a large demand for castor cake, the first year's operations, on the basis of a co-operative capital of Rs. 7,500, a profit of 25 per cent. has been secured and the cake sold below the market rate. It has secured also that the market rate has been much lower than it would have otherwise been. In this case the co-operators were almost exclusively the gardeners themselves, but the management was in the hands of a keen local man, not however a gardener. A larger manure supply society has recently been promoted in one of the sugarcane tracts in the Deccan, with a capital of Rs. 20,000. It has succeeded in coming out satisfactorily from the first year's trading, though there will be no large actual profit, but it has caused the price of fish-manure (in which it dealt) not to rise as was invariably the case in former years. The result of its experience is to indicate that such a society is best run when the shareholders are co-operative credit societies who can buy for the benefit of their members rather than individual cultivators."

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* A paper read at the Provincial Co-operative Conference held at Lucknow in February 1916.

If, as may be hoped will be the case, the steps taken this year lead to a more general demand for cake for manurial purposes, some of the co-operative societies working in tracts where intensive cultivation prevails might find it worth their while to start on this business. They can be assured of every assistance from the Department, and most probably they will find the larger manufacturer anxious to meet them half-way in the matter of prices. It need scarcely be said that no such step is to be recommended, unless a good sale is practically assured; but, where potato-growing is already well established, the market exists on a considerable scale and will probably rapidly expand. In such areas a special society for the provision of manures might prove feasible, and is likely to prove a boon to the cultivators. The writer has conversed with some of the cultivators in the Cawnpore District and finds that the potato trade is growing, and there is a big export business to other parts of the provinces. Some are able to obtain village refuse for their fields; but a considerable number use castor or *nim* cake. These cakes are also occasionally used for tobacco-growing; but as a rule this crop is only grown on the fields immediately adjoining the village site. In time it may be hoped that our cultivators will follow the example of those of Bombay and liberally manure the sugarcane grown for the manufacture of *gur*. At the present prices of *gur* it would amply pay them to do so.

Apart from the areas which specialize in garden crops, openings for the sale of manures may be anticipated in another direction. When the societies which have already been formed to supply water to their members begin to work, the writer feels assured that a demand for manures will spring up. The immediate result of a regular supply of water—at times when it is wanted—is the putting down of a better class of crops, and the growing of special crops, such as chewing-cane, vegetables, etc. These require manure and it is very soon found that it pays to apply it. In one district, arrangements are being made for the sowing of castor as a border crop in order to provide a regular supply of cake. It is believed that in a few years' time those societies which can supply water will find themselves called upon to supply manure also; and that they will find it a profitable business with small risks.—[H. R. C. HAILEY.]

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THE MATERIAL BASIS OF CO-OPERATIVE CREDIT.*—The credit of any individual person rests partly upon the amount and value of his property, and partly upon his character and reputation for success or failure in his agricultural or business undertakings. His credit, we may say, can rest either upon a *material* basis or upon a *personal* basis. It is the essence of the co-operative credit movement that by incorporation with joint unlimited liability the personal credit of a group of persons becomes very greatly strengthened. This outstanding fact does not, however, diminish the need or advantage of developing credit with a material basis, *i.e.*, credit based on the property of the borrowers, as an additional support.

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* A paper read at the Provincial Co-operative Conference held at Lucknow in February 1916.

Personal credit must always be somewhat weak, even when it is joint among thirty or more members, especially in India. The danger arises from the fact that a widespread natural calamity, such as drought or flood, can affect simultaneously in a similar way at the same time all members of a society. At such times of trial societies are liable to break up through dissensions. Hence it is to the interest of every member not only to strengthen his own material credit, but also to see that other members strengthen theirs.

The building up of material credit must necessarily be a slow process. It is to be done by accumulating productive property—land, cattle, good ploughs, carts, and other tools and implements, and by improving the land with drainage or fencing, or sometimes with silos, grain pits or *pucca* buildings for co-operative or individual purposes. Another very important way of increasing material credit is by improving the methods of cultivation, for the cultivator is thus assured of producing a larger income and he obtains a larger margin over his bare expenses of living. It is of most vital importance that every member should see that every other member is carrying out his cultivation properly and is marketing by the most economical methods. Every member should learn to say to himself:—" My fellow-member's profit is my own safety."

Not only farm implements, buildings and better cultivation, but also immaterial property rights, such as good and long leases, or possession of occupancy rights, are important bases of security ; and every society should do its utmost both to protect its members in the continued enjoyment of such rights, and to secure new rights for them whenever possible. Except when the past record of a zemindar gives a practical guarantee against unreasonable disturbance, the policy followed by some societies which consist almost wholly of members possessing occupancy rights, of restricting the admission of new members to candidates possessing occupancy rights would seem to be sound. This policy should certainly not be discouraged even though it may lead to individual cases of hardship amongst cultivators unable to acquire occupancy rights.

Although rights of tenure are of great importance as a basis of credit, at the present time the main basis of improved credit of rural societies must be the adoption of better methods of cultivation and the accumulation of property. Some of the property, such as ploughs and the smaller implements, must be owned individually; but many things, such as seed stores, oxen, machines, grain or silage pits, wells, and so forth, should be co-operatively owned, that is to say, they should belong to the society and the oxen and machines should be hired out according to a pre-arranged plan. The question may well be asked whether some part of the reserve funds—not the whole—might not with propriety and advantage be invested in durable machines or in improvements of a lasting character, such as wells, irrigation channels, grain pits, drainage works, fencing and so forth wherever security of tenure for such works can be obtained from the zemindar.

If the three means of increasing material credit be steadfastly pursued—that is to say: better cultivation, accumulation of productive property, and acquisition of tenancy or proprietary rights—the credit of co-operative societies will be so greatly increased that it will be possible considerably to reduce the rates of interest at which cultivators borrow from societies. By taking the necessary steps to increase their material credit they will have learnt to value capital property, for they will know its productive capacity. Having larger incomes, and being able to borrow at lower rates, they will be able to borrow much larger sums to be applied in still further improving their methods of cultivation and the area cultivated. Thus there may be gradually brought about, through taking proper steps to increase the material basis of co-operative credit, a general raising of the standard of life of all members of the societies.—[H. STANLEY JEVONS.]

REVIEWS.

Preliminary Note on Sheep-breeding Experiments by the Civil Veterinary Department, United Provinces.—By E. W. Oliver, M. R. C. V. S., F. Z. S., Superintendent, Civil Veterinary Department, United Provinces. Printed at the Anglo-Oriental Press, Lucknow, 1915.

This pamphlet briefly describes the sheep-breeding experiments at present in progress in the United Provinces. Attempts were made in India from time to time since 1825 to improve the breeds of Indian sheep, but they met with little success mainly on account of two reasons, *viz.*, absence of any sound, scientific, or systematic basis and want of continuity in operations. No regard was paid to the choice of localities and the methods of breeding, resulting generally in the ultimate return of the features of the progeny to those of the prepotent indigenous parent. It seems to have been thought sufficient to merely import rams of a famous breed, without regard to dissimilarity of the pasturage, water, climate, and other conditions in India to that of their natural home and little or no attention seems to have been paid to the most important point of all, *viz.*, the selection and suitability of the indigenous ewes and the intelligent mating of the progeny.

The Civil Veterinary Department, United Provinces, seriously took up the subject of sheep-breeding in 1912. Several Australian sheep raisers as well as wool experts were consulted with a view to obtain the soundest information and help in the matter. After taking a survey of the present sheep-breeding tracts of the province, experimental work has been started at ten centres. One of the main objects of these experiments is to "evolve and fix a breed of sheep of superior wool-growing and flesh-forming capacity which would eventually breed true to type and at the same time be able to withstand the vicissitudes of Indian climate and other adverse conditions." A system of grading up from carefully selected indigenous ewes by crossing them with rams of superior wool-producing breeds was considered the soundest plan to follow. With this end in view indigenous ewes were crossed with specially imported New Zealand Merinos and a few of the Riverina rams.

Having obtained half-breds the following experiments are now in progress :—

(*a*) Crossing the half-bred Merino ewe with pure Merino ram.
(*b*) Mating half-bred Merino rams and ewes together (unrelated strains).
(*c*) Crossing the native ewes with half-bred Merino rams.

It is from (*a*) and (*b*) that the best results are anticipated.

The results so far obtained are satisfactory. The half-bred Merinos yield 5 to 6 lb. of wool per animal per year, whereas the yield of the native sheep of the province rarely reaches 2lb. The former has also been highly spoken of by wool experts and the Cawnpore Woollen Mills purchased it at 8 annas per lb. when the country wool fetched only 4 annas per lb. The author recommends that shearing should take place twice in a year, *viz.*, in March and September, and deprecates the practice of three shearings at present in vogue in the province. As a result of experiments it has been found by the author that in India also, judicious and periodical dipping of sheep is very beneficial to the fleece as well as to the general health of the animal. Among the difficulties attending sheep-breeding experiments on improved lines are the somewhat large mortality of the imported stock owing to the extreme change of climate, the prevalence of epizootics and parasitic diseases. Even the indigenous sheep are not altogether immune to these scourges. It is hoped, however, that the graded up progeny will acquire from the native parent or grand-parent a degree of immunity to the effects of climate and to certain of the most dangerous sheep diseases.

The proper handling of sheep and wool including careful methods of shearing, dipping, and packing of fleeces, etc., is practically unknown to Indian shepherds. The appointment of a young Australian who has had a thorough experience of this work is therefore recommended.

The experiments are full of promise and we await the further results with interest.—[EDITOR].

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Mysore Agricultural Calendar, 1916.—Published by the Department of Agriculture, Mysore. Government Press. Bangalore. Price 1 anna.

THIS Calendar seems to have been prepared on the lines of the Madras Agricultural Calendar. It opens with a short account of the progress made by the Agricultural Department, Mysore, during the year 1915, in which the point most deserving notice is the inauguration from the beginning of the current year, of the system of selling improved implements to ryots on an easy instalment system of payment. As this is an interesting experiment some of the conditions under which this system is worked are here given for the information of the readers of this Journal. The value of implements sold to any one ryot or landholder under these rules and outstanding against him at any one time is not to exceed Rs. 2,000, the rate of interest charged being 5 per cent. per annum. An agreement in the prescribed form has to be executed and a deposit of one-fourth of the value of the implements to be made before the supply is sanctioned. The period of payment of instalments is fixed at three years in the case of implements costing Rs. 100 or less and five years in all other cases. All sums falling due under these rules are recoverable as arrears of land revenue, a stipulation to this effect being inserted in every agreement executed by the hirer. Besides the ordinary calendar, monthly notes containing useful hints to cultivators are given below the calendar for each month. It also contains small articles on (1) the New Bar-Share plough; (2) Potato Cultivation; (3) Smut on Jola (*Andropogon Sorghum*); (4) Kondali Hula (*Ophiusa* *melicerte*) on Castor; (5) Co-operative Credit in Mysore; (6) The Rice-case Worm; (7) Foot and Mouth Disease; (8) Cattle Manure: How best to collect and conserve it; and (9) Manuring of Sugarcane. In short, it may be said that the present Calendar and the one for the previous year contain much useful information, and as these are also published in the vernacular, information given therein will not fail to reach those for whom it is intended and this will no doubt considerably facilitate the work of the Department.—[EDITOR.]